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New Advertisements.

In the growth of THE ELECTRICAL WORLD in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits or interested in electrical matters has not failed to be appreciated by advertisers. Readers will find it to their advantage to keep their eyes on the advertising as well as the reading columns. The following are the new advertisements in this issue:

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Vol. IX. NEW YORK, MAY 28, 1887. No. 22.

IN view of the interest and importance attaching to the annual and general meetings of the American Institute of Electrical Engineers last week, we devote considerable space in this issue to the report. As the body is a national one, and as many of the members, now growing so rapidly in number, cannot attend these pleasant and profitable gatherings, we feel that we are benefiting at once the Institute, the absent members and our readers by printing the papers and discussions somewhat fully. The activity and the enthusiasm displayed at the recent meeting, accenting as they do a new departure after three years of slow but solid growth, are the best evidence that could possibly be afforded of the permanence, stability, usefulness and prosperity of the Institute. The resolve of the Institute to "better what is done" is also displayed in its prompt action with regard to permanent quarters about which it had been talking so long. This special movement, while it is one in which the members will take the leading part, is also one that must commend itself to all who desire to see the highest interests of electrical science and application advanced. The Electrical Engineers will carry their plan through to success, but it is fitting to point out that their action has already stimulated other like bodies, and that the American Society of Civil Engineers and others, are holding out hands of friendship and assistance, and are desiring to join in a plan that would assure to New York a magnificent central institution devoted to the arts and sciences. We quote elsewhere an article from an engineering contemporary on this subject. The Electrical Engineers may, meantime, take pride in the fact that they are well to the front in this great movement. Moreover, the Institute is lending its aid to the New York Electrical Society, which is to give an Electrical Exhibition this fall in the fine building of the American Institute, which has set aside a large sum of money for that purpose. Details of this will be found elsewhere in our columns. Altogether, it looks as though 1887 will be a memorable year in the electrical annals of New York City, and that the work carried out will do much to arrest attention on the new developments of electricity, and to summon capital to their exploitation.

THE intention of the New York Electrical Society to give an electrical exhibition this year, at the American Institute, is one for which it must be heartily praised. The whole field of electrical application has been changed and revolutionized since the Philadelphia Exhibition of 1884, and it is well that the public should get a full and comprehensive idea of the way in which electricity is ready to-day to meet its wants and add to its comforts, with a thousand new and novel devices. We understand that the society has been pledged a large portion of the space in the large building of the Institute, and from the manner in which the society's ideas are being approved already, no doubt can be entertained, even at this early stage, as to the success of the exhibition. While the exhibition will include all that is newest and latest, it will make a special feature of the storage of electricity and of the electrical transmission of power. The conditions for the exhibition are peculiarly favorable. The building is ready, it is in a central location, the charge for space is extremely low, and the steam power is supplied free. The society took steps to make this exhibition early last year, but found it to be too large an undertaking then. This year its plans are well matured and its forces await the call.

IT is to be regretted that none of the papers read before the American Institute of Electrical Engineers were printed for distribution at the meeting. Though the discussions did not lag, it requires considerable concentration of the mind to follow a paper read for the first time and to make mental notes of the points brought out likely to create discussion. We hope to find this detail seen to at subsequent meetings. All that is required is that members should have their papers ready two or three days earlier than hitherto.

THAT part of the discussion of the American Institute which relates to the admission of junior members will be read by a great many with interest. The point raised is undoubtedly an important one. It will perhaps be settled by a study of the experience of other scientific bodies in dealing with the same matter. We note, as bearing on the question, that the English Society of Telegraph Engineers and Electricians has just held its first "students' meeting," under the presidency of Prof. Ayrton. The fact that a society of such high standing thus encourages participation in scientific work and discussion by the younger men within its reach is not without significance.

PROBABLY none of the meetings of the American Institute of Electrical Engineers has brought out more interesting papers than that just concluded, and the variety of the points discussed shows the keen interest taken by the members in the proceedings. We think the time has come when the example set by a few prominent electricians will be followed by all the others, and that the Institute will become the medium of publishing to the world the results of electrical progress on this side of the ocean. The reproach is sometimes heard that America undertakes no original research, or at least very little, and must look abroad for contributions to electrical science. We think this is entirely wrong in fact, and that the reproach should no longer be allowed to stand. To remove it, as stated before, our electricians must come forward like those in European countries, and we believe the time is not far off. We are convinced that there is enough original work accomplished here to occupy the attention of a dozen meetings a year, and that it is of such a nature as to bear directly on the practical side of the question treated.

MR. T. D. LOCKWOOD contributed to our columns last week the third of his interesting articles on details in telephone work. The points he has brought out or touched upon have all been well worthy of note; and his remarks, coming from one who is a "past master" in the art, will have their weight. One passage has its application to other departments of electrical works, and we quote it: "It is a good thing for any young man entering the electrical business to have a kinsman high up in the scale of positions, or to have a director behind him as a kind of big brother, but better far is it to have a persistent, persevering, painstaking, work-loving nature, and a large modicum of conscientiousness and grit. Eternal vigilance is the price of successful telephony." The inventors and electricians of merit and prominence to-day have won their position by uncersing work, and striving after something better than had before been done or found.

THE ratio of iron in the magnets and armature of the Gramme dynamo is very ably discussed in Mr. Dugald Jackson's Institute paper. The curves which show the rise in the output of the machine per pound of wire with increasing amounts of iron in the armature, corroborate the results of the best practice of recent years, and show also in what respect the older machines were defective. The limits to which the amount of iron in the armature can be carried with profit is also pointed out. It would be most interesting if Mr. Jackson would continue his experiments on the Siemens type of armature, so that a comparison could be made between the two types. The curves show that in armatures defective in iron, saturation is reached long before the field has attained its full strength, and that any additional strength imparted to the latter is current wasted. It is well to remark, however, that the results obtained apply only to maximum output per pound of wire with *minimum* amount of iron. It is evident that we can increase the output of a machine by increasing the amount of iron contained in it, but in that case the conditions of minimum amount of material are not fulfilled.

THE steps recently taken by the American Institute of Electrical Engineers recall to mind the noble words with which Joseph Henry opened the proceedings of the Washington Philosophical Society when it was started. "The importance of such a society," he said, "must be evident to all who are acquainted with the history of science. It is mainly through the influence exerted and the assistance rendered by such associations that science is advanced and its results given to the world. Man is a sympathetic being, and no incentive to mental exertion is more powerful than that which springs from a desire for the approbation of his fellow-men; besides this, frequent interchange of ideas and appreciative encouragement are almost essential to the successful prosecution of labors requiring profound thought and continued mental exertion. Hence, it is important that those engaged in similar pursuits should have opportunities for frequent meetings at stated periods." Did the officers and members of the Institute desire to express their views and feelings in the language of others, they could not find a finer utterance than that.

THE admirable paper read last week by Prof. Elihu Thomson, before the American Institute of Electrical Engineers, and printed in this issue, seems to open up a new and wide field in the application of alternating currents. The reason for the preponderance of the repulsive action between conductors under the conditions described in the paper is explained with the greatest clearness, and its following out by Prof. Thomson can leave no doubt of the correctness of the theory advanced. Not the least interesting part of the paper is devoted to pointing out the manner in which this inductive repulsive action can be applied in the construction of instruments for measuring alternating currents, for alternating current arc lamps, motors and the like. Prof. Thomson laid particular stress upon the latter development, and justly so, for obvious reasons. The employment of the alternating current to charge storage batteries, or, in other words, its commutation into a continuous current, where such is wanted, seems also to be in a fair way of solution, a method of its accomplishment being suggested. It is, as yet, too early to assign to its proper place and limit the part which the alternating current will take in the electric arts. It has started on its career with most rapid strides, and it now only remains to devise means for its efficient utilization. These means include appliances for its accurate measurement, regulation and distribution. Certain it is that Prof. Thomson's brilliant paper cannot fail to act as a powerful stimulus to those whose attention is now absorbed in the direction indicated, and the fruits of which will soon be noted. We hope that at a later meeting of the Institute Prof. Thomson will give to the world his practical results, which he has only hinted at in the present paper.

The House Fund of the American Institute of Electrical Engineers.

Although the Institute had discussed the subject of a House of its own, like that of the American Society of Civil Engineers, for three years, it was not until Wednesday, May 18, that it supplemented committee discussion by direct action. Then, in about ten minutes, it raised over $1,600, as described in the report on another page. Since that time the movement, though not urged at all, has been gaining in favor everywhere, and to-day (Tuesday) it has every promise of complete success. It will be seen from the appended list of contributors, nearly every one of whom are members, that the amount now pledged reaches nearly $4,000. Contributions are already coming in from all parts of the country. The list up to May 24 is as follows:

LIST OF CONTRIBUTIONS.

Prof. W. A. Anthony	$ 50
C. S. Bradley	200
W. M. Callender	100
C. A. Cheever	100
Curtis & Crocker	100
T. A. Edison (first)	100
S. D. Field	100
W. K. Freeman	50
F. B. Herzog	250
" (Conditional)	250
W. T. Hunt	10
W. J. Johnston	500
E. H. Johnson (first)	100
F. W. Jones	100
Julien Electric Co. (Wm. Bracken, pres.)	100
T. C. Martin (first)	100
Capt. Michaelis, U. S. A	20
J. F. Morrison	200
G. M. Phelps	100
G. M. Phelps, Jr	100
R. W. Pope	100
Pope, Edgecomb & Terry (first)	250
F. J. Sprague	50
C. E. Stump	100
W. C. Temple	25
Prof. Elihu Thomson	100
W. Wallace	100
J. Wetzler	100
S. S. Wheeler	100
Edward Weston	250
Total to May 24	$3,805

The Council of the Institute has determined to add to the House Fund by a course of lectures by gentlemen prominent in electrical investigation or industry. These lectures will constitute a course—some more technical, some more popular—and the proceeds, which should reach a substantial figure, will be a great addition, while the lectures will serve an educational purpose in an admirable manner. These lectures will be delivered during the fall. Mr. T. D. Lockwood, whose ability in this direction is well known, has been one of the first to place his services at the disposal of the Council. Mr. E. H. Johnson, president of the Edison Company, promises a popular lecture in aid of the fund, at his own expense, and is most cordial in his approval of the plan. Prof. Elihu Thomson will contribute another lecture. The course will include five or six lectures, all on electrical topics, and some will probably be delivered at Columbia College, others being given in such places as Chickering Hall.

It may be added that the Institute is already receiving promises of further contributions. President Coffin, of the Thomson-Houston Company, for example, sends very kind words of encouragement, and other gentlemen of prominence are also pledging their support in the same manner. Besides this, the library of the Institute is sprouting with the rapidity of spring growth, having received within the last few days several important contributions, including a set of patent office reports, dating back to 1848, from Mr. C. Colné, of the Panama Canal Company. It is also to be noted as significant that since the list of members was issued, preliminary to the May annual meeting, nearly 40 leading electricians and others well known in electrical pursuits have come into membership.

The indorsement of the step taken by the Institute, by the press, has been warm. The *Mail and Express* says:

"The American Institute of Electrical Engineers, at its annual meeting yesterday raised over $1,600 in ten minutes toward a fund for permanent quarters. That amount has already been largely increased, and it seems likely that the whole sum required, some $30,000 or $40,000, will soon be in hand. The movement is a timely one in view of the immense extension of electrical science and industry, and the Institute, a national body, has our hearty good wishes for its success in the endeavor to secure one more endowment for science in this city."

The *Commercial Advertiser* says:

"The American Institute of Electrical Engineers, which was established in this city about four years ago with purposes of national breadth, has so far strengthened itself by healthy growth that it is planning to establish a permanent home, with assembly rooms, library, record rooms, etc. The sum of $1,600 was raised at the meeting last evening toward this object, and about as much more has been secured to-day. The movement is one of public interest, its tendency being to promote organization in a quarter where organization is in every way desirable."

The *Evening Post* says:

"New York is rapidly becoming the centre of scientific as well as literary movements. The American Institute of Electrical Engineers, which has for three years past been meeting annually at the house of the American Society of Civil Engineers at 127 East Twenty-third street, held its fourth meeting yesterday at that place, when a large number of papers were read. The Committee on Permanent Quarters, Mr. G. M. Phelps, Jr., Chairman, presented a report during the day strongly recommending that steps be now taken to secure the home in this city that had been talked of so long. In less than a quarter of an hour the members present raised $1,600 for the purpose, and promises of liberal gifts were made by others. Several large sums have been added to the list to-day, and the movement is already a pronounced success, receiving as it does the support of Mr. J. F. Morrison, President of the National Electric Light Association; Prof. Elihu Thomson; Prof. W. A. Anthony, of Cornell University, William Wallace, and others, well known in connection with electrical investigation and application. It is said that the effort will be made by the Institute, which has over 200 members, including all the leading electricians in the country, to secure quarters in common with the American Society of Civil Engineers, who are now greatly cramped for want of room.

The movement has taken yet another development, with which the Electrical Engineers have sympathy and which their own immediate success has done much to stimulate and assist. We quote as follows from a recent article in the *Engineering and Mining Journal* on the subject:

The marvelous development of the engineering arts in this country, which is partly the cause and partly the effect of the rapid growth of our engineering societies, makes more and more evident the want of a really good engineering library, where works upon any branch of the art can be consulted by those who live at a distance, as well as by those who are able to do so in person.

The American Society of Civil Engineers, the oldest of our technical societies, has the nucleus of a good library on civil engineering subjects. The American Institute of Mining Engineers set out with the intention of having no library and no "local habitation," nothing, in fact, over which quarrels might some day come; but under the force of circumstances books and periodicals were forced upon it, and a magnificent collection of mining and metallurgical products were given to it.

The Society of Mechanical Engineers is still in its infancy, though of wonderfully vigorous growth, and it has as yet the merest name of a library. Many of the members of each of these societies are members of one or both of the other, just as the practice of each specialty of the engineering art laps over at many points on the others The mining engineer is frequently called on in his practice to solve problems or to do work which strictly lie at one time in the domain of the mechanical engineer, at another in that of the civil engineer, and the mechanical and civil engineer have frequent occasion to consult and use the work of the metallurgist.

Though the tendency of the times is more and more toward the division of an art into specialties, it is also true that it becomes more and more necessary that those who practice each special department of engineering should have a knowledge of the progress being made in the other. It is for this reason that so many of the members of any one of the societies are members also of the others. Each of the societies in forming a library would, in a great measure, have to duplicate that of the other societies, each would have to employ a librarian and have a library hall.

If the societies were to join in establishing a Union Engineering Library, join in the expense of a single building and a single librarian, their united means would soon enable American engineers to establish such a library of professional books and models as would prove of incalculable benefit to those in every branch of engineering, and would make it practically available to engineers in every part of the country.

There is, we are convinced, a strong sentiment among the members of the several societies in favor of such a union of efforts and means for this purpose, and we shall be pleased to have their views on the subject expressed through these pages.

It is not now necessary to enter into details of plans, but it appears to us that the American Society of Civil Engineers, the American Institute of Mining Engineers, the Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Architects, the Chemists, and possibly some other societies might join. It would not be difficult to arrive at a just basis for co-operation by which the value of contributions of each society to the common library would be credited on an annual contribution to be made by each.

We do not at present suggest or advocate any specific plan. We simply desire to have the subject discussed with the view of securing to those engaged in any department of engineering the great benefits which would come from the use of a good library. The propositions scarcely need argument—that a good engineering library has become an absolute necessity to the profession, and that the benefits to be derived from it can be secured far more fully and economically by co-operation of the societies than in any other way.

Whatever may be the outcome of this, it is evidently highly necessary that the Institute of Electrical Engineers should go forward and show how well able the electrical profession is either to provide a house of its own or to join on equal terms in carrying out the larger programme. We shall be glad to receive and record any contributions to the fund.

An Electrical Exhibition in New York.

At the meeting of the New York Electrical Society, the Electrical Section of the American Institute, held on May 25, the project of holding an electrical exhibition in this city next fall, under the auspices of the society, was brought forward, and received the hearty approval of the members. This exhibition, which is to be held in the Exhibition Hall of the American Institute, is intended to include all the applications of electricity, and as none such has ever been held in New York, it is expected that the opportunity thus offered will be largely availed of.

The American Institute has signified its willingness to aid the society in its work in every possible way, and the American Institute of Electrical Engineers has also assured the society of its co-operation and support. It is most probable that the course of lectures now being organized by the American Institute of Electrical Engineers will be in some way, through the agency of the society, connected with the educational work done at and by the Exhibition.

The details of the exhibition will shortly be made public, and thus ample time will be afforded for the preparation of intending exhibits. Information on the subject can be obtained from the President, Mr. J. M. Pendleton, 49 Broadway; Mr. J. Wetzler, secretary, 175 Potter Building, or Mr. C. W. Hull, superintendent of the American Institute, Clinton Hall.

One Arrester for Each Circuit.

To the Editor of The Electrical World:

SIR: I agree with Mr. Wood in regard to connecting lightning arresters. I have used them for four years, and connect to but one arrester for each circuit. At present I have eighteen circuits thus protected and have had very little trouble. The arresters should be cleaned often, and located where accessible. G. A. REDMAN.

ROCHESTER, N. Y.

The Wood Theory as to Damage of Dynamos by Lightning.

To the Editor of The Electrical World:

SIR: Have read with considerable interest the article as to Mr. J. J. Wood's lightning arrester for dynamos. His theory may or may not be correct, but we are certain it will not do in practice. This company has doubtless been troubled more by lightning than any other, having had as many as eighteen lamps disabled by a single flash. Perhaps it would not be out of place to state that it took place when we had in our station a lightning arrester, such as that described by Mr. Wood.

When we are without lightning arresters, the towers come next and best take off the lightning, but when a better one is placed in the station the result is it passes the tower and goes to the works, and every lamp it passes through is disabled by having its shunt wire burnt. We have never had a machine disabled by lightning, but have about eight lamps on an average burnt by every heavy lightning storm. SAVANNAH.

SAVANNAH, GA.

The Extreme Importance of Attention to Little Things in Telephony.

To the Editor of The Electrical World:

SIR: I noticed in a recent issue an article on construction and inspection by T. D. Lockwood, and I believe all he says to be true; in fact, I know it to be true in many towns and cities within 15 miles of Boston. But in justice to *linemen* and *inspectors* there is something to be said on the other side of the question.

I know of a young man who had less than *one month's* experience in the *electrical* business who was made "manager" of an exchange of almost 150 subscribers, and his duties were to put in instruments, inspect them, to run new lines with the help of the operator (who had charge of the office nights) when the job was more than he could handle; in addition, he had to keep the finances of the office correct, or make up the difference out of his own pocket, and for this work he received the extensive salary of $50 per month, while any telegraph company will pay a lineman $60 to $65 per month.

Again, telephone employés are expected to work Sundays for the same pay ($50 per month), and no extra pay is allowed. The poor "manager" is expected to be within call of the office at night to relieve the night man if the occasion requires, and often has to stay all night at the office.

If telephone companies would pay salaries and hire *men* who know their business, Mr. Lockwood would not have occasion to notice so many irregularities.

BOSTON, MASS. ONE WHO KNOWS.

The Hebrew Technical Institute, 34 and 36 Stuyvesant street, this city, was opened to its friends and patrons on May 19, when the various classes were to be seen in operation, and when addresses were delivered by prominent men. The Institute is an excellent school, and there is no doubt that its workshops will turn out many a skilled artisan for the electrical and other industries.

Annual Meeting of the American Institute of Electrical Engineers.

The meeting was called to order at the House of the American Society of Civil Engineers, 127 East Twenty-third street, New York, at 8:45 P. M., May 17, by the president of the Institute, Mr. Frank L. Pope, after the inspection of the telemeter system, under the Brooklyn bridge, Franklin Square, and of the cable and electric lighting plant of the bridge.

The PRESIDENT: We have met this evening to hold the fourth annual business meeting of the Institute of Electrical Engineers, for the election of officers for the ensuing year and the transaction of any other business that may come before the meeting. The first thing on the order of business is the reading of the reports. The secretary, I think, has his report ready.

Pending the reading of the report, the president appointed a nominating committee, Capt. Michaelis chairman.

Mr. R. W. Pope then read the secretary's report as follows:

SECRETARY'S REPORT.

As the Institute is about entering upon its fourth year, it appears to be an appropriate time to review its record, examine the field of its operations, and prepare for extending its usefulness in the future. The reasons for its existence are more apparent than they were three years ago. While all of us realized at that time that electrical industries were in their infancy, the importance of scientific training was not appreciated as it should have been. It is now generally admitted that the best commercial results can be obtained in the electrical field by following out scientific theories, especially where they have been confirmed by practice.

If we have learned all there is to be extracted from the study and practice of electricity, the Institute has no mission. If, however, we are progressive and desire to obtain further knowledge of the art as we perform our various duties in this growing field, then we should not only continue the good work we have undertaken, but seek to extend the usefulness of the Institute by bringing to its support all who are in any manner interested in the various applications of electricity, and are desirous not only of profiting by the experience of others, but are willing to contribute their own ideas for the benefit of their fellow members.

The Institute having now apparently passed the critical period in its existence and attained a recognized scientific standing at home and abroad, far in advance of all other strictly electrical associations in the country, membership in it is correspondingly appreciated.

It is the only association, national in its character, which brings into the arena of discussion all branches of electrical research, and it may be added that in none of them are such subjects so thoroughly and intelligently treated, and so accurately recorded, and published for the information of absent members, as well as for future reference. To build up such an organization, to secure the active support of patient, zealous workers until it attains full recognition as a worthy public institution, is a difficult undertaking, and that we have reached our third anniversary with bright prospects for the future is a very encouraging fact.

Two previous reports have directed your attention to the importance of holding more frequent meetings in order to awaken and maintain interest in the welfare of the Institute, which it was feared might lose ground unless opportunities were offered for occasional gatherings during the year. Acting upon these suggestions, four meetings have been held since May 18, 1886. The proceedings of these meetings were very fully reported in the electrical papers, and were also copied in foreign electrical periodicals. They have been beneficial to the Institute in various ways, and it is to be hoped that our members will contribute during the coming year a sufficient number of papers to enable us to hold at least eight similar meetings.

Nothing whatever has been accomplished toward securing permanent quarters, and this is perhaps the most serious obstacle which remains to be overcome. The continued courtesy of the American Society of Civil Engineers in granting us the use of their rooms for our council and general meetings, while most heartily appreciated, does not satisfy the natural desire for a home of our own, and until this end is attained it is hardly possible that the full benefits of organization can be realized. As our receipts are now greater than our expenses this surplus ought not to be reduced. The present condition of our affairs is such that I believe a much better showing may be made during the coming year, and I see no reason why we should not move forward with confidence toward attaining that most desirable achievement in the history of any similar society—a permanent record of scientific papers and discussions of which every member should be proud, based as it is upon the intelligent researches of its supporters. Respectfully submitted,

RALPH W. POPE, Secretary.

NEW YORK, May 17, 1887.

A motion to print the Secretary's report in the Transactions was adopted.

Mr. R. W. POPE: I might say, in regard to the list of members, that I wanted to avail myself of the opportunity to send it out with the invitations to the collation to-morrow, and in order to do that, I had no time to compare it with the records and check it off, and I find that I omitted one or two names—the names of E. P. Thompson and that of William Lee Church, a recent member; and we have added to-night the following new associate members, W. Dwight Wiman, Francis R. Upton, C. L. Edgar, Clarence E. Stump, J. O. Ellinger, Alexander B. Wright, Otto A. Moses, Lieutenant E. L. Zalinski, United States Army, I. L. Roberts, and Asst. Eng. W. D. Weaver, United States Navy—ten in all.

The PRESIDENT: The list of members shows a healthy and continuous growth. I think we may congratulate ourselves on the interest that is being taken by the electricians of the country in the prosperity of the Institute, which is evinced in the best possible manner by sending their names in as candidates for membership, and we may congratulate ourselves also on the quality of the new accessions as well as upon their number. We are now ready, I believe, to proceed to the election of officers, and Captain Michaelis will read the nominations as chairman of that committee.

Captain MICHAELIS: The committee appointed to make nominations have availed themselves of information received from members. There has been discussion of the subject of filling vacancies during the past month, ever since the last Council meeting, and their prompt action is due to the fact that they were well informed in regard to the wishes of the members, and in suggesting names they have not, probably, strictly followed the idea which is the basis of our Constitution with regard to geographical distribution, but they felt that, during the early years of the Society, it would be well to have on the Board of Managers men who would attend its meetings and be active in forwarding the interests of the Institute. In regard to one nomination, in which the feeling was unanimous, they are sorry to have to report that they could not meet the unanimous wishes of the members they have come in contact with during the past month, and that is in regard to the office of president. It has undoubtedly been the wish of every member of this society that our present distinguished president would be willing to accept another term; but he has positively declined, notwithstanding all influences that were brought to bear upon him. He will not accept the office again, and his reasons are, namely, what he considers the best interests of the society. In the first place he desires to establish the precedent that there should be a rotation in office, and that one term is sufficient; but I am glad to say that he has consented to permit his name to be used as a candidate for vice-president. The committee have therefore nominated for the office of President a gentleman than whom there is no other one who has shown more interest in our progress, or who has done more for us; we nominate for the office of president Mr. T. C. Martin; for vice-president, to fill the full term of two years, Mr. F. L. Pope, Col. R. R. Hazard and Prof. W. A. Anthony; for secretary, it is needless to state the committee's nominee, our present incumbent, whose able report we have just listened to with great pleasure, Mr. R. W. Pope; for treasurer, the committee has transferred one of the managers of the Institute, as the present treasurer has been promoted to be vice-president; we nominate to that office Mr. George M. Phelps, Jr.; for managers, Messrs. Schuyler S. Wheeler, Joseph Wetzler, A. C. Fowler and William Lee Church.

It was moved and seconded and carried unanimously that the secretary cast the ballot of the Institute for the gentlemen nominated.

The motion was carried.

The PRESIDENT: I will appoint as tellers to receive this ballot Mr. Wheeler and Mr. Shelbourne.

The secretary deposited the ballot with Mr. Sidney F. Shelbourne, as teller, who thereupon announced the names of the persons elected.

The PRESIDENT: Gentlemen, you have heard the names of candidates selected, as announced, and I hereby declare them elected. We are now ready, I suppose, for any other business.

Mr. G. M. PHELPS: I have a resolution to offer. We have all heard in the able report of the secretary the remarks which he has made in respect to our want of habitation from the fact that we are still indebted to the kindness, but at the same time charity, of others for a roof over our heads when we get together. It is not disagreeable to come to the house of the civil engineers; it is always a pleasure, but at the same time we would all be happier and the society would be more useful if we had our own roof; and the desire for that is very general, and some of us are of opinion that we are better able to accomplish something in that line than we have thought we were, if we would really put our hands to it and undertake it seriously, and with the view of having it done at once, I would offer a resolution in hope that it will bring out an expression of opinion and a favorable vote.

Resolved, That in view of the general interest evinced for three years past by members in proposals for some permanent quarters for the Institute, that a committee be appointed at this meeting to report at the meeting to-morrow on the best plan to be adopted, and the sum necessary for the purpose named.

The motion was seconded.

Mr. SHELBOURNE: I should like to say that, as I understand it, a committee has been appointed and now exists, as just suggested to me and as serves my memory, for that very purpose, a committee on permanent quarters. I think that committee was appointed more than a year ago, if not two years ago.

A MEMBER: Three years ago.

Mr. SHELBOURNE: Yes; and I should like to know what that committee has been doing all this time, and who composed it.

Mr. MARTIN: I was present at the last meeting of the council, Mr. President, and the committee in question had no further report to make, and as I understand it this is not any usurpation of the functions of that committee. It is appointing a new committee to start in afresh, and to make a record, which the other did not do. I am not aware that the other committee has any *status*.

Captain MICHAELIS: Discharge the other committee?

Mr. MARTIN: It expires, sir.

Mr. SHELBOURNE: The point is quite pertinent, but in general I understand that that committee holds on from this day forth.

Mr. PHELPS: In point of fact that question has been out of the hands of the committee more than a year.

Captain MICHAELS: Put in the word "new," that will settle it.

The PRESIDENT: With your permission, Mr. Phelps, I will make the change.

Mr. SHELBOURNE: I do not like to see things duplicated. It is proper that when a committee is appointed for any purpose, before any other committee is appointed for the same purpose that that committee should make a report, or decline, or become *functus officio* in some way. If the committee has not made a report, or has not declared what it was going to do, or considers itself as having reported, or discharged, or defunct, why, then, of course, Mr. Martin's motion would be proper, but only upon that statement.

Mr. MARTIN: That committee, if I am not mistaken, Mr. President, was a committee of the council, not of this body, and the council, as master of that proceeding, requires no further service from that committee. We are now asking for the appointment by the chair of a committee out of this body.

Mr. SHELBOURNE: Then my remarks fall.

The PRESIDENT: I think Mr. Martin is right, that it was a committee of the council, and as they do not seem to have accomplished very much there certainly can be no harm in a committee of the whole council trying to see what they can do.

Mr. MARTIN: I would like then to withdraw, if in order, that word "new." It is not a new committee of the Institute at large; it is a committee.

Mr. PHELPS: I think under that ruling, which seems to be quite right, if the old committee was a committee of the council the resolution had better stand as it did in the first place.

Mr. WETZLER: I think we could separate that matter by making a motion to the effect that the old committee be discharged.

Mr. MARTIN: The minutes of the secretary show that it was a committee of the council.

Mr. R. W. POPE: I might add that they have made sundry reports, from time to time, to the council of different ideas of new buildings put up that we might get, but there has been nothing definite done.

The resolution was unanimously adopted.

The PRESIDENT: I will appoint on that committee Mr. Phelps, Mr. Martin and Mr. Hamilton.

Mr. R. W. POPE: In conversation with Captain Michaelis this evening it seems that he has some ideas about the question of permanent quarters, and he has had a good deal of experience in that direction, and while I do not know if it would be in order to add him to the committee, yet I should like the committee to receive the benefit of his experience in the matter.

The PRESIDENT: There is no number specified and I will therefore add Captain Michaelis to the committee.

Mr. PHELPS: I would like to offer a further motion, to wit: That the council be instructed and authorized to proceed to incorporate the Institution under the laws of the State of New York appropriate to such society, and with power to designate from their own number a Board of Trustees. Seconded.

Mr. PHELPS: It is obvious that in respect to the resolution that has been offered for a committee to report a scheme for permanent quarters, that should that resolution bear fruit, and should we take up that work in earnest, it is essential that we should be incorporated in order to take possession of any funds or property which we might acquire.

The PRESIDENT: There is no question about the necessity of it.

The motion was carried.

Mr. WHEELER: I give notice that at the next meeting—to-morrow—I will offer the following amendment to the Constitution:

"The council shall have power to elect juniors who have been engaged in electrical or cognate interests for one year or more. These juniors shall not have the privilege of voting, but shall be entitled to be present at the meetings and take part in the discussions. They shall be required to pay one-half the initiation fee and five dollars annually with one copy of the transactions, or three dollars annually without."

Mr. R. W. POPE: This, I suppose, is a notice of a proposed amendment to the rules. It is not exactly in accordance with the rules as they stand: for instance, the present initiation fee is five dollars: half that would be two dollars and a half, and half the annual dues would be five dollars. If this is the intention of the resolution, to pay half the initiation fee—two dollars and a half—and half the annual dues—five dollars, including the transactions, and three dollars without the transactions, is that the idea?

Mr. WHEELER: That is the idea.

Mr. R. W. POPE: It seems to me it would be better to take it in hand and make the matter right so that there will be no misunderstanding about it. It is sufficient for you to give notice that you propose some ammendment, and then put it in some shape that will accord with the rules as they now stand.

Mr. WHEELER: That can be done to-morrow, can it not? I simply offer that as a notice.

The PRESIDENT: There are two things to be considered in that matter. It seems to me that one is, there is a large number of these young men, if we do not take them in at the reduced price, we won't get them at all. And another matter is that I think it would be well to have some limit of age, or some limit of time; otherwise you might have men coming in as juniors and staying as juniors until they were seventy years old.

Mr. WHEELER: I will suggest that it is not the age that will always determine whether a man is qualified to become a junior or not. It would be better to limit his time as a junior to a certain number of years after he has been admitted as a junior.

The PRESIDENT: I should think five years would be as much as would be necessary.

Mr. PHELPS: That would be an ample limit, because if a man—young or old—comes in as a junior and can pay three dollars a year, if, after working five years longer at electricity, he could not then earn enough to pay us our full fee, he cannot be much of a member.

Mr. SHELBOURNE: I have not heard of this proposition before this evening. The feeling with which it strikes me is decidedly adverse. We are to lower the dignity, and importance, and character of this society by proposing to admit some young men, say they are up to eighteen years of age. How many of these young men do we propose to get? And what will these young men expect to gain here for their money? This is not a school; it is not a laboratory; there are no instructors. They simply come in here to hear, perhaps, older men talk. Will they pay their money for that purpose? Will they pay three dollars a year to come in and sit at these meetings, or the annual meeting, or at the dinners, which the society will perhaps give two or three times during the winter, and pay their dollar for the dinner? I say no. I say that the gain that this Institute would derive from such a purpose as that will be more than offset by the loss which the Institute would suffer among such men as occupy the higher walks of science, such as Prof. Thomson, and Prof. Anthony, and those people who are at the head of the electrical and scientific world. We have now an associate membership which provides for any number of just such young men if they want to come here. The only question is about their paying the ten dollars instead of the five. I had something to do with preparing the amendments to the Constitution and By-laws of this Society, and I know we had a long discussion there as to how we could accomplish just what this amendment seems designed to accomplish. There was a clause put in as to the qualifications of associate members, "those who by study or experiment are seeking to become identified with electrical science or with the utilization of electricity." Now, I say that will include all that you can get into the society, of these young men. If you go to work to make an age qualification, you want an age qualification all through. If the membership of this Institute, which now comprises a hundred and seventy-five members and associate members and honorary members, if this society should create an interest and feeling

among those men and bring them here at these meetings, we would have society enough, and we should have enthusiasm and interest enough. Now, instead of making Prof. Anthony or Prof. Thomson, or any other professor or high science man, feel that the society has lowered itself, we wish to keep it where it is and try to create an interest and try to create a greater interest and even enthusiasm among those who are not among the class of those who might be brought in. (Applause.)

Mr. MARTIN: I must say that Mr. Shelbourne's remarks are extremely weighty, but I will just mention one case which occurred in my own knowledge to-day of a young gentleman thoroughly versed in the science of electricity who, to make his first step, takes a position at ten dollars a week. He wants to come into this society. How can that man pay our dues?

Mr. SHELBOURNE: That is a consideration for us to address to such an institution as the Cooper Institute. We are not an educational institution. If we had a course of study and a professor that was eminent to teach them something, then that would be a question of benevolence, and how much benevolence we could afford upon these young men. But this, I say, is a question as to the dignity and standing of this Institute; and if there are such young men, how many such young men could you get? Would you get twenty-five young men to come in here if you had your fees ever so low? And if you did get those twenty-five wouldn't you alienate the feeling of fifty men of standing who would feel that this society has no footing to stand on? Probably later on this institution will be on a par with the Royal Institution in England.

Mr. MARTIN: What we want to do is to make this institution useful. It seems to me that action of this kind must have been taken by similar scientific bodies at some stage or other of their progress; but I must admit that Mr. Shelbourne's remarks have impressed me very much. When this comes up to-morrow it may be determined that it would be well to move slowly. I know that some of the older societies have this junior membership, but so far from regarding it as anything detrimental, their view of it is that it serves as a reservoir and feeder to the classes that are above, and that it is one of the proudest things in the lives of those young men when they can pass from the lower stage to the higher.

The PRESIDENT: I think that our friend, Mr. Shelbourne, is somewhat disposed to underrate the character of the young men whom we have in view. We are thinking of the class of the young men who are attending the technical colleges and schools, who are just graduating from the technical schools, almost all of them under age, almost all of them filling positions where their pay is very small, and yet men who, in a very few years will be, as we know some of them have become in five years, at the top of the profession. I do not think that we are in any special danger of getting in the undesirable element that seems to be feared. There is only a certain class of young men who take the slightest interest in proceedings of this kind, and the others would not come near us if we paid them half a dollar for every meeting they attend. But in my own experience I have known a great many young men in a similar situation to the one Mr. Martin referred to who would be very glad to come here and listen to the discussions, and ask questions, and to learn what they could. We are certainly nothing more or less than an educational society. We are endeavoring to educate each other by comparing experiences. (Applause.) Certainly a young man of any age, or an old man who takes any interest in the subject, cannot possibly attend any of our meetings without learning something of value to him. If he is not interested in the proceedings, he will not come and will not trouble us. That is my feeling about it. At the same time, I think very careful consideration ought to be given to all that Mr. Shelbourne has said. There is a great deal of force in many of his remarks. I think we ought to go slowly, and be very careful.

Mr. SHELBOURNE: I have no disrespect for the class of young men that the chairman refers to, or that Mr. Martin refers to. But these young men are, it seems to me, not numerous enough to benefit this Institute, and the Institute is not in a position at the present time to benefit them. Our meetings outside of those during which we have had dinners, where special papers have been read, and special discussion upon those papers, have been entirely confined to the annual meetings, the business meetings of this evening, and the general meeting. And I do not see enough interest that we can offer to these young men, however little they are able to pay, which would induce them to come here except upon the expectation of being members by and by. Now, if they have graduated from some technical college and are going out into business where, if they are smart enough men, they very soon will grow into a position either in the electrical world or in some other branch of the scientific world, they will be able in a few years to come in as associate members under the by-laws. Therefore it is not because I have a disrespect to that class of young men. I respect them very highly; but I am considering what good we can do to them, and what good we can get, and what motive they can have to come in with us.

Captain MICHAELIS: I have listened with much interest to what Mr. Shelbourne has said, and I must confess that I agree with him from beginning to end. It seems to me that he has not considered the point of this amendment. At our meeting in December, 1885, this question was discussed for hours, and, finally, after this prolonged discussion, the following was adopted as a definition of associate members: "Associate members shall be such persons as are, or have been, connected with the utilization of electricity, or who, by means of study or experimental investigation, are qualifying themselves to become identified with electrical science, and such others to whose admission no objection can be made by any member of the council." Now, if anybody can draw up a broader clause to cover the admission of anybody, I would like to see him do it. There is no age qualification. We can take in a boy of ten or a man of eighty. The point of this amendment is simply and solely a pecuniary one. It does not matter whether they add dignity to the society or detract from the dignity. It is simply a question of dollars and cents, and nothing else, because, under the present constitution, the council are perfectly competent to elect these men as associates. I think we ought to decide whether we want to reduce our dues. In some societies it is the practice to give the council authority to remit a portion of the dues in deserving cases; but it is a simple question of payment and nothing else. There is no dignity involved or loss of dignity.

Mr. PHELPS: Except that the proposed class shall not be voters.

Capt. MICHAELIS: Except that the proposed class shall not be voters.

Mr. WHEELER: If the object were attained by empowering the council to remit a portion of a person's dues that person would feel it very much more than if he were paying the dues of some regular class. I am very much impressed by Mr. Shelbourne's speech with the delicacy of making any amendment to the constitution, and venturing on any matter of this kind; but I think there are some other considerations which have been spoken of—the dampening effect of having young men here has been spoken of. But most men who are prominent in electricity are very anxious to have young men educated, and it is for the interest of most of the big men who have made money in electricity to have young men educated; they have suffered from the inability to find young men who have understood the subject. Mr. Edison, I know, offered from twenty-five thousand to fifty thousand dollars worth of apparatus to any college that would establish a school of electricity. The men alluded to as likely to be driven out by the presence of young men are just the ones who are anxious to have a class of young men grow up and learn these points, and I think that, instead of that driving those old men away, it would make them willing to come here and talk for the sake of giving the young men a chance to hear them. I know persons who spend a good deal of their time in conversation with their assistants explaining things to them, and sometimes repeating to them things that have been brought out at some of our meetings. In a small way I have done it myself with men in the employ of our company. I have spent hours at different times telling them things that have been brought out, because I thought that instead of being time lost it would be time gained if I could bring them to an understanding of a part of what other people knew. They should simply do that part of the thinking for me hereafter. I have been very much impressed by the remarks made on the danger of lowering the grade. But the same class of young men is introduced in some of the other societies. In the society whose rooms we are in to-night they have class of junior members which is very valuable. I am a junior member of this Society of Civil Engineers because I cannot qualify as a full member. A full member is required to have spent seven years in actual engineering work, not as a man to carry out work, but as a man who can design the whole thing and do it. A junior member is one who has been in that class of work for two years. He has got to be one of the head men of the enterprise he is in. Now, there are a great many men who are valuable to have on hand who have not being doing that kind of thing for several years. They are going to have a meeting here to-morrow night, at which will be read a scientific paper on "Strains of Bridges." It is going to be read by a Doctor somebody, a junior member. Now, ofcourse, we may not have as high grade as that in our junior membership, but we may be able to gradually secure it. The Society of Civil Engineers has also a class of associate members who are very similar to our class of associate members. They are people who are interested in scientific work, but who are not engineers; for instance, chemists and scientists of that kind. They join the society as associate members; that is, something similar to our class of associates which includes business men. Now, if we can have a class of junior members so as to take in men who have not had quite so much experience as is required by our regular membership without lowering our grade, it would be a very good thing to do, and I hope that in doing that we will have the benefit of advice of some of those who have spoken to night, because I have been very much impressed with many things said since I offered my notice.

Capt. MICHAELIS: Much has been said about the American Society of Civil Engineers, and I want to say that was considered in December, 1885, and that clause was so worded as to include all the juniors of the American Society of Civil Engineers. To prove that it is a matter of dues and nothing else, I want to say that I have been thirteen years a member of the Society of Civil Engineers. The non-resident members are entitled to all the privileges of membership; their annual dues are somewhat less because they have not the privileges of the club-house generally. Now my only dues as a non-resident member are fifteen dollars, and I would like Mr. Wheeler to tell me what his annual dues are in the American Society of Civil Engineers.

Mr. WHEELER: Exactly the same.

Mr. SHELBOURNE: Then it appears that the arguments advanced by Capt. Michaelis and Mr. Wheeler do not agree. Capt. Michaelis says that this amendment is simply a matter of getting money, and if we put that out as a confession before the scientific world, and before the world generally, and before the newspaper press, I say that that very confession is a lowering of our dignity. If we want a building that we can say is our own; if we are going to be a society that will ever be on a par with the Royal Society of England, why I say we want to keep up the dignity of this American Institute of Electrical Engineers. Let us be an institute of electrical engineers, with a reputation as wide as this broad continent, and let us produce our publications and papers that will be on a par in science with those that are produced over in England, but don't let us confess that we are going out into the world to gather a few young men to get their three dollars a year.

The PRESIDENT: I don't think any of the proposers of this plan of junior membership did it with the idea of raising additional revenue.

Mr. PHELPS: I was going to say myself that I thought Mr. Shelbourne had rather inverted the meaning of Capt. Michaelis. If I understand Capt. Michaelis, he looked at the pecuniary matter from two different points of view. The principal one was that we probably could not afford to give the privileges we contemplated giving for three dollars a year. That is, I think, an important consideration. We may take such action in respect to privileges which could only be afforded for three dollars on eleemosynary considerations. Therefore, I think there is a good deal to be thought about in respect to this whole measure, and I think as the measure stands now that one modification (if we carry it out all), might very properly be made by striking out that three dollar clause. If a young fellow cares enough about the thing to join it he ought to care enough about it to want the proceedings. I should be rather in favor of striking that out and making a man pay his five dollars. He need not take the proceedings away if he does not want to; but let him have them.

Mr. SHELBOURNE: If, after what I have said, these gentlemen choose to resolve this into a committee to go ahead and do this thing, I say let them. I have delivered myself of what I have had to say. I have said it fearlessly, plainly, honestly, and now I have done with it.

Mr. R. W. POPE: The discussion that has come up on this question, it appears to me, has taken a turn which shows that it is a matter of importance, and should not be acted upon hastily, and furthermore that the two or three propositions that I have on hand depend on each other. If we get a building here we may not be able to do this thing, and we may offer such privileges as no man would think them cheap at ten dollars a year, because I believe it should stand until we have proceeded a little further, and we find out what we are going to do, and that it will be acted upon leisurely, and that all these arguments be taken into consideration. It appears to me that would be the most satisfactory way of doing it, instead of rushing it through without a consideration of all the facts that may come up hereafter. It appears to me that the council has a good deal of time that it could devote to this subject, and in such a way that it would not interfere with our proceedings here to-day or to-morrow, and I believe that they could act upon it intelligently and consider all these questions. And if it is not absolutely necessary to put it through at once, I believe that that would be the best disposition to make of it. The council is sometimes rather pressed for want of subjects for discussion, and I think this would be equally as good as the wire gauge. (Laughter.)

Mr. MARTIN: I think it is quite possible that we may find this point in the rules of the societies in Europe, such as the one to which Mr. Shelbourne referred relating to this subject that we are now considering.

The PRESIDENT: I would say that the English Society of Telegraph Engineers and Electricians, of which I have been a member almost from the beginning, has a class of membership of that kind designed for the same purpose that we are trying to accomplish. I do not recollect precisely what the regulations are, but, of course, that can be considered with other matters that will come up for discussion. That class was established after the society had been in operation some five or six years, and evidently was intended to supply a need which had manifested itself.

The notice of motion was withdrawn, the matter being understood to be left to the further consideration of the council.

Capt. MICHAELIS: At the request of several members I desire to offer the following resolution: The Institute desires to place upon record its appreciation of the services rendered by its retiring president, Mr. F. L. Pope, and its regret that he has deemed it for the best interests of the Institute to decline a unanimous tender of re-election. Seconded.

Carried unanimously.

The PRESIDENT: I thank you very much, gentlemen, for your kind appreciation of my services. They have by no means been what I would like to have made them. But circumstances have prevented my being in attendance at a great many of the meetings. I have always endeavored to be on hand when I could. I am sure that you will find that you have not made an unprofitable exchange in the worthy successor that you have elected for me, and I feel sure that we shall be pulling together and make the new administration the most successful and prosperous one that the Institute has yet seen.

The meeting then adjourned. At its close the council elected Prof. Elihu Thomson as vice-president, to fill the vacancy caused by the retirement of Mr. T. D. Lockwood; and Mr. E. P. Thompson as manager, to fill the vacancy caused by the election of Mr. G. M. Phelps, Jr., to the treasurership.

WEDNESDAY MORNING SESSION.

The meeting was called to order in the rooms of the American Society of Civil Engineers, 127 East Twenty-third street, New York City, at 10:45 A. M., by the retiring President of the Institute, Mr. Frank L. Pope.

Mr. Pope addressed the meeting as follows:

Members of the Society and Gentlemen:

In bidding you welcome to the fourth annual meeting of the Institute of Electrical Engineers, it affords me much gratification to see such a large and representative attendance, and to note the evidently increasing interest manifested by the electricians of the country in the welfare and prosperity of our organization.

The year which has elapsed since our last annual meeting has proved one of unusual prosperity in all branches of legitimate business having to do with the manifold industrial applications of electricity. Without exception, so far as I am aware, the manufacturers of electrical machinery, apparatus and supplies are all fully employed; some of them are working overtime, and many of them have in contemplation or actually in progress extensive additions to their facilities.

While rapid development, enlargement and extension seems to be at present the rule in every department of the science and art which we, as an organization, especially represent, it may not be amiss to refer to the exceptional progress which has been made in certain specific directions since our last meeting. Among these may be mentioned the transmission and distribution of mechanical energy through the agency of electric motors, and especially the application of these to minor branches of manufacturing in large industrial centres, and to the propulsion of street railroad cars; the largely extended employment of accumulators or storage batteries for the lighting of buildings and railway passenger cars; and the introduction of long distance incandescent electric lighting, which has at length apparently been made both practicable and profitable by the employment of alternate currents and induction apparatus. Last, but not least, should be mentioned the new art of welding metals by the aid of the electric current, which seems likely to occupy a vast and immediate field of usefulness, and to create numberless new industries, to say nothing of revolutionizing some of the existing ones which have come down to us almost unchanged from the days of Vulcan and of Tubal Cain.

I am sure that it will be a source of gratification to you all to learn that the prosperity of the Institute of Electrical Engineers has kept fairly abreast with that of its members and co-workers in their individual and professional capacities.

The series of monthly meetings, each preceded by a dinner, which have been held in this city during a portion of the past year, have proved to be most successful and enjoyable reunions, and have certainly done much to strengthen the Institute, by increasing the interest of non-resident members as well as of those residing in the more immediate vicinity of New York.

Several exceedingly interesting discussions which have taken place at these meetings have been reported in the professional journals on both sides of the Atlantic, and thus the information brought out has been made available to the profession generally. It is proposed to continue this commendable innovation during the coming year, and I have no doubt but it will henceforth become a permanent feature of our proceedings.

The courtesy and liberality of our much-esteemed sister society, the American Society of Civil Engineers, has enabled us to enjoy for another year the hospitality of the convenient and comfortable rooms in which we are now assembled.

While I feel sure that every member of the Institute appreciates to the fullest extent the value of the assistance which has thus been rendered to us as a society in the days of our youth and feebleness, yet in the judgment of some of our most esteemed members the time has arrived when we may feel justified in making a determined effort to secure adequate, commodious and convenient headquarters of our own. Within a day or two past, a movement has been set on foot to raise the necessary funds to carry out this project in a fitting manner, and I am more than gratified to say, with excellent prospects of success. The undertaking will be presented to-day in a definite form for the consideration of the members, and I feel certain that each and all of you will individually do everything in your power to insure its early and complete success. It is hardly necessary to say, that the establishment of the Institute in a building of its own, equipped with a library, reading-room, and perhaps ultimately with an experimental laboratory, will give us a standing second to that of no other institute in the world devoted to a special branch of art or science; it will directly benefit every industrial enterprise in the country having to do with electricity; it will increase the confidence of capitalists in the importance, remunerativeness, and stability of electrical enterprises, and will in every possible way be of the utmost advantage not only to our own members, but to all who are in any way connected with electrical enterprises. I trust therefore that my successor in the honorable position of president of this Institute may be enabled to signalize his administration by the completion of this most desirable undertaking.

In conclusion I desire to tender my acknowledgments to the officers of the Institute and the members generally for their kind and hearty co-operation in carrying on the affairs of the organization during the past year.

Mr. POPE: Gentlemen, it gives me great pleasure now to introduce to you the newly-elected president for the coming year, Mr. T. C. Martin, whom you all well know.

Mr. MARTIN then read the following address:

Fellow Members of the Institute:

Your action last night, placing me next in succession as president to so distinguished an electrician as Mr. Frank L. Pope, and so soon after Dr. Norvin Green has occupied this chair, is one that only the results can justify. Although my connection with the Institute dates back to its foundation, and although in the three years of its existence I have been afforded the opportunity of participating in its management, I cannot venture to regard your decision as entirely personal. I would interpret it rather as a generous recognition of the fact that the Institute has still the larger part of its initial work to do, and that that work must be carried out chiefly by the younger element, which constitutes an ever-increasing part of the membership. For this great honor, and for this sign of your confidence, my thanks must, therefore, find their best expression in what the Institute achieves during the current year.

We stand to day at an important stage in electrical investigation and development, and yet it is not given us to see or to say what will be its position in the long vista or perspective stretching through the second half of the present century. As Dr. Priestley reflected one hundred years ago: "It may be said that there is a *ne plus ultra* in everything, and therefore in electricity. It is true, but what reason is there to think we have arrived at it?" Priestley was of those who were permitted to gaze afar off at untrodden fields of discovery, but who did not enter in. To-day the evidence of what has been achieved tells us that the greater lies before. The time is one, in fact, when science, and such a department of it as ours, offers to the more adventurous and inquiring spirits the rewards that were once mainly to be found in geographical discovery and in the prosecution of trade, but which are wanting now when even the interior of Africa has been traversed, and when commerce is carried on at apparently a diminishing rate of profit to capital. The electrician has gained, meanwhile, a foothold on the Atlantic seaboard of his new continent, and, subduing a wilderness of theory, speculation and doubt, has already won some of the noblest provinces that ever rewarded the industry and the genius of man. But beyond him lie the ranges of distant mountains, and westward of their peaks is the territory out of which he has yet to carve a score of States unnamed. Toward that great west of his science the electrician advances, and even now he has the first fruits of exploration. But while there is this onward movement for the pre-emp ion and occupancy of virgin soil, we see going on an equal development in the realms already won, invention being heaped on invention, and improvement added to improvement. Speaking as one who had witnessed this change, Dr. Werner Siemens said recently: "We still remember the time when we listened with incredulous wonder to the strange fairy tale that the mysterious new force, electricity, could transmit messages with lightning speed across whole continents and the oceans which divide them; and that this same agent could precipitate metals in a solid form from their solutions and change night into day;" and yet, as he went on to point out, this is not less the time "when the world-encompassing telegraph no longer suffices for the needs of intercourse, but must give place to the transmission of oral messages by the telephone over distances, in comparison with which the natural range of the human voice appears as nothing; when the latest fruit of the union of science and technology—electro-mechanics—in its rapid development, offers to mankind ever new and immeasurable fields for the investigation and utilization of the natural forces."

We are dealing, however, with the immediate present, and have to keep pace with such a rapidity of achievement that our plans each day have to be adjusted to larger conceptions and wider horizons. The position was admirably described this month in a leading magazine by Mr. G. B. Prescott, Jr. "The improvements of methods," he said, "the refinement of machines and appliances, and the bringing of science down to daily work and business, moves on so swiftly that the new machine, or the new one of a year ago, is already old. The reduction of refractory ores in electric furnaces, where immense carbons, fed by the largest dynamos in the world, give a heat never used before, excited world-wide wonder only a few months since. * * * * Even the very recent railroad accident in Vermont has created a demand for storage batteries for lighting lamps in cars that is so active that every railroad shop in the land is examining new accumulators. Never in the history of any business was there such an eager desire to obtain new machines, new tools, and new methods as in the manufacture of electrical apparatus." This is well put. In fact, the electrical statistics of to-day are nothing short of colossal. To go no further than our own country, we find an investment and capitalization in simply the leading electrical industries—telegraphy, telephony, electric lighting, and electric power—of a sum of, at least, $350,000,000. There are in America about 700,000 miles of telegraph wire. Last year 320,000,000 telephonic conversations were held. Over 150,000 arc lamps, and incandescents verging on 1,000,000 now instruct the public eye that the electric is the light before which all others must pale their ineffectual fires. At least 10,000 electric motors are employed in the most varied industries, and while the electric railways here are carrying passengers at the rate of more than 3½ millions annually, the extraordinary increase now going on in that branch promises that the figures will be doubled within the year, with at least from 50 to 75 electric roads in operation. When to these figures we add the thousands of dynamos and vats used in electro-plating, the countless electric appliances used in medicine, surgery and the miscellaneous arts, and the endless variety of electric apparatus for convenience, safety, protection and comfort in the house, office, train or hotel, we arrive at sum totals dealing with which a statistician needs all his ability to mass and classify. It is no exaggeration to say, moreover, that in the electric industries, hundreds of thousands of our most intelligent citizens of both sexes find remunerative and agreeable occupation; nor is it an exaggeration to affirm that at a time when all great departments of manufacture must depend for success on the degree of technical culture and skill displayed in them, none rests on a more strictly scientific basis than ours.

Where in the midst of all this activity, where in a sphere of so much outgrowth, onlook and uplift, do we find the Institute? That is the question for us to answer. The Institute has in its three years of life done good unobtrusively, but it is not discharging its responsibilities nor carrying out its mission to the full. Our fellowship, though growing rapidly from among those already active in electrical pursuits, must be greatly enlarged to embrace the constant accessions to the electrical ranks. Cornell University alone has now 59 students in electrical engineering, and those young men as they enter on practice feel the need of association with the men already at work. Stevens Institute is sending out numbers of capable electricians, and but the other day I had the pleasure of meeting the zealous and enthusiastic "electricals" of the Massachusetts Institute of Technology. For all of them, and many others, we must provide a place in our membership.

But with an expansion of the Institute must come, as my predecessor, Mr. Pope, said last night, proper accommodation for the books, apparatus, portraits and documents of the Institute, fitting quarters for the secretary, and a place to preserve the numerous relics and mementos which are to be given us, but now lie dusty and neglected and widely scattered. The Institute must have a local habitation as well as a name. It should also, as suggested in a resolution adopted by you, be incorporated at as early a date as possible.

Another matter of importance is the strengthening of the ties of friendship between the Institute and kindred societies at home and abroad. We have here no end to serve but the promotion of science and industry, and to that end we are endeavoring to devote our energies with singleness of aim and purity of purpose. I would be glad to see steps taken so that any member of electrical bodies abroad shall be entitled, while in America, to enjoy all the facilities and resources of the Institute. I would esteem it a great privilege to be in any way instrumental in more closely uniting the organizations here at home. I may particularly mention, in this respect, the New York Electrical Society, which, though local in work, is the oldest of the kind and has made a most creditable record. The feeling toward us on the part of that society is heartily kind and fraternal, and I do not see why the two bodies cannot be brought together, and, perhaps, by compromise and mutual concession, benefited in a close union. The first approaches have, indeed, been taken in the membership enjoyed by a great many of us in both organizations.

I might touch on other topics, but can close by one remark including them all: We have our work as a national Institute to do. It lies ready to our hands. It may not be easy of accomplishment, but at least the effort can be made, and we have it in our power to render the Institute more influential, more representative, more helpful.

The PRESIDENT: We will now have the paper by Mr. E. P. Roberts, of Cheyenne, on Practical Experience with Storage Batteries, a most important topic, and one which deserves the most careful attention of the members. The Secretary will now read the paper.

Mr. R. W. POPE, Secretary: Mr. Roberts omitted sending a title for his paper, so I took the liberty, as an old newspaper man, of putting on a title myself—"Storage Batteries in Practice." Mr. Pope then read the paper, which is as follows:

STORAGE BATTERIES IN PRACTICE.

Since I had the honor of reading a paper on storage batteries at the annual meeting of 1885, we have discarded storage batteries distributed in various localities as the source of supply of current to our incandescent lamps, and have now all lamps connected with our incandescent dynamos. Having, however, a large number of cells we have placed in position at our station about 1,200 of the same, charging them at night and using the stored current for day lighting and power, both of which are small in amount. In case of an accident to our machinery at night we could use our storage plant to tide over the time required for repairs, or until the majority of lights could be turned off. We have not yet had a call, however, for such service, although we always have the batteries charged to a considerable extent before dark.

Since 1885 we have tried crockery and glass cells, with plates *suspended* in the same from glass rods and separated by glass rods from each other. This was a great improvement. The cells are placed on beams of a triangular cross-section, having a four-inch base, which, in turn, rest on glass insulators, Western Union pattern, screwed on pins fastened on cross pieces. The beams are first painted and then given a coat of paraffine. The insulation from cell to cell is much improved thereby. When lead cells are used they are placed on porcelain insulators on the beams, flat places being cut on the vertical angle of the beam.

I am informed, with what degree of correctness I do not know, that storage batteries have been much improved lately over those with which I have had experience, but, even if such should be the case, I should hesitate to use them where gas lighting is cheap and where it might be desired to use only a *few lights* in *each* of a *large* number of localities separated by considerable distances. For special cases, however, I have no doubt the storage batteries can be used advantageously, particularly when the advantages of incandescent electric lighting are considered as being of financial value.

A few of the disadvantages arising from the conditions in the first part of the above paragraph are:

1st. A large plant in each locality is needed because of possible drain on same. The ordinary use in a residence may be 15 lamp hours and the possible use 100 lamp hours. This is an extreme example, but is not exaggerated, as it was the necessary margin we had to provide, when we had storage plants in each house requiring light, for from 15 to 20 per cent. of our customers.

If several customers can be supplied from one battery plant the margin of extra supply can be reduced. In such case it will be necessary *either* to connect all the customers on all the batteries connected on multiple arc, and then disconnect the batteries and charge same in series; or, if it is desired to use a meter system in which discharge bears a certain proportion to charge, an attendant must be ready to throw extra batteries on circuit needing same, and note name of customer using extra supply.

2d. A large number of plants means a number of small stations to maintain and at which to keep supplies—distilled water, acid, etc.

3d. With a number of small stations it is difficult to regulate E. M. F. to current desired. However small the percentage of E. M. F. lost in the discharging wires, the E. M. F. of the batteries should rise as lamps are turned on, or the lamps will be below candle-power, when a number are used, if for one or two the proper E M. F. is used; or it will be necessary to strain the lamps when a few are used, in order to have normal brilliancy when a number are desired. To still further complicate matters, the E. M. F. is higher at the start, particularly if only a few lamps are "on," than it is later in the evening. These differences in E. M. F. are small, but are sufficient to vary the candle-power of the lamps.

If, therefore, each customer is connected with one or more batteries for his sole use the following takes place: As darkness approaches one or two lights are turned on and are raised to abnormal candle power, straining lamps and making consumers dissatified with any less light later on, and as the customer's eyes become tired the light drops, possibly not below the normal candle-power, but the *comparison* is bad, and it requires considerable power of persuasion on the part of the company's "talker" and loss of his time as a "worker" to make the customer believe that his eyes are at fault and not the light. It may be that an entertainment is given in the house, and then the drop of candle-power is more noticeable, although it may not fall much below the normal.

Of course it is possible to design mechanism to overcome all such troubles, to throw in extra cells and extra batteries as required, etc. To design mechanism to accomplish such work with reliability and which will not be too costly for maintenance or prohibitory on account of excessive first cost, is considerable of a problem. Matters are further complicated by the necessary use of charging mechanism. Also, it is desirable to have switches so arranged that it will be impossible to have charging current "on" when lights are being used *from* a battery. The writer has run 1,000 lights in such a manner (with charge on) for over a year, but does not advise it from any standpoint except necessity.

If a few large stations are used, the E. M. F. at same can be readily shown at main station, and regulated from same if desired, or an attendant can be sent to any station needing regulation.

My experience teaches me that if batteries can be charged under inspection and allowed to have a discharge without excessive variation in amount of same, that the batteries will give *much more reliable* results than in any other way. The nearer this can be approached the more satisfactory will be the service.

If, therefore, it seems to be advisable in any city to erect a storage battery system for general distribution, I believe it will be found best to erect a very few large battery stations at the various centres, and that the interest on the extra cost of the wire leading from the same to the lamps, over what would be necessary if each light were close to a battery, will be far more than saved in the lessening of attendance alone; and that the avoidance of other evils I have mentioned will thus be clear gain.

Mr. C. O. MAILLOUX: I was very much interested in the paper prepared by Mr. Roberts, and I quite agree with him that the most promising method of employing storage in lighting large areas will be by means of a series of groups of batteries suitably located with regard to the distribution of light to a certain group and supplied from a central station. I think that it is possible to so arrange matters that we can send the energy from the central station to the various groups at a rather high potential, and then distribute it at a lower potential from these groups; in that way we shall save copper in the conductors for carrying the energy and we shall get the benefit of distribution at a low potential. In nearly all instances, it is found impossible to place the charging station in the centre or equally distant from all the various groups. Usually it is found cheaper to buy land on the outskirts of a town and to establish a central station there. I know that in the case of incandescent lighting, the idea of distribution by different sets of feeders has been adopted, and in some cases with a marked economy in the cost of conductors. I have in mind the case of a person interested in electric lighting, who submitted to me some data regarding an installation in some city in Pennsylvania, where he produced an economy of over twenty per cent. in the use of omnibus wires or feeders for the mains, by adopting the plan of distributing the energy in fractions to those mains, so to speak,

Instead of using one set of feeders to distribute the energy to the mains, and a set of feeders of large diameter, he found that he could save copper by using distinct sets of feeders of smaller diameter and striking the mains at a point more favorably situated with respect to the particular group of lamps; and in this way, having divided the total number of lamps into groups on the map of the city, he was enabled to distribute his conductors; and that is exactly what it is proposed to do with the storage battery. I do not think that it is as yet the ideal system. It is far too young and full of deficiencies to compare with the systems that have been in use for four or five years, with very able men studying their defects and seeking to remedy them. But from what I know of the case I think that I can quite heartily sympathize with Mr. Roberts in his tribulations—I have no doubt he had quite enough of them; but I think if he had seen some of the more improved forms of battery that are now in the market, perhaps his labors would have been materially lessened.

Mr. WETZLER: On a recent occasion I brought out the fact that a company had been started at Haverford, Pennsylvania, to run an electric light station and to have an auxiliary storage plant. The idea was this: It is conceded that the maximum number of hours for lighting probably does not exceed four or five for incandescent lighting. During the remaining time an incandescent station is practically running far below its capacity. Now the argument was that if they could put in a number of engines, dynamos and boilers which could be kept running practically twenty-four hours—that is to say, if any means could be devised by which that could be accomplished, there would be a great saving in cost of installation and operating expenses. The way in which that was to be overcome was by the installation of storage batteries. They have a certain number of dynamos there which they keep running, I believe, some twenty hours during the day, and during the time the current is not used directly from the dynamos it is stored in the batteries, and drawn upon as occasion may require. I believe there are some 600 cells now in operation, and I understand, too, that the distribution to individual houses has also begun; that is, having a battery in each house. What the success of that station is to date I do not know, but it certainly deserves attention.

Mr. GEO. A. HAMILTON: So far I have had no experience at all with storage batteries; but I might say that telegraph companies have considered the feasibility of using them, and while they have not arrived at a definite conclusion in regard to them so far, it seems that the number of cells that will have to be provided will make the plant cost so much that it will be a bad thing to use. The thing is still under consideration, however, as I said before, and after we have had a little experience with it I may be able to say something on the subject. If we could group the potentials along one after the other, the same as we do with dynamos, it would be a very good thing to do; but that seems to be impossible, because some of the batteries would be drawn upon much more than others. On the other hand, if we group them up, take different groups or lines of different resistances, then we would have to have such a number that the first cost and the wear and tear on them after a while would make the whole cost too much for us. It does not compare at all with the dynamo. Possibly within the coming year we may be able to tell something definite in regard to it, because it is possible we shall use a few. I do not know what the experience has been in England, but I think they have only used them to a limited extent there.

Mr. FRANK L. POPE: There is another application of the storage battery that has not been discussed that I would like to say a few words about, which might be of interest to the members. A short time since I was applied to by the president of a street railway company, in one of our largest cities, that is about to build a new line over new territory about five miles in length. It is proposed to run something like twenty cars on it, and he came to consult me about the possibility of working the line by electricity, and stated at the same time that there were insuperable objections to the use of any sort of overhead conductor, and very serious opposition to the use of a conduit or anything which would occasion the slightest disarrangement of the pavement; and therefore he wished me to investigate the question of running cars by accumulators. In undertaking this investigation I examined a car which was being experimentally run on Eighth avenue by the Julien Electric Company. I was very much more favorably impressed with the results attained than I expected to be, although it was easy to see that a great deal better work could be done with it than was being done there. In the first place, like nearly all the street railway lines in New York city, the Eighth avenue is of the most miserable construction. It would not be tolerated on a contractor's dirt road out in the country to run steam engines over, and yet these people in New York who are using the most costly form of motive power that is used in the world to-day of any sort—horse-power—are using one-half to two-thirds of it in battering their tracks and cars to pieces against each other. There is opportunity for a good deal of missionary work on the part of our sister society (the Society of Civil Engineers) in that direction. I made a careful investigation of the subject and procured some cells, and had them put under test by one of our most careful and accomplished young electricians, a member of our Institute, and from the results attained by him I became quite convinced that it was possible to operate street cars at a cost something less than that of horse cars at all events, and possibly considerably less. It is difficult to get at the matter theoretically, because no one knows exactly what the average power is that is required to propel a horse car. The load varies greatly at different times of the day, and the resistance varies greatly with the condition and amount of dirt on the track, whether it is wet or dry, and how much there is of it, and all that, and nothing but a series of practical experiments will give us exact results. But we were sufficiently encouraged by the results we did get to go on and have a car built, embodying all the improvements that we could think of in the way of excellent running gear and highly efficient motors, and that car, I suppose, will be ready for operation sometime within the next month or two. Or rather I should say we intend to put the car into actual service on an existing line and run it and carry passengers with it the same as any other, and to carefully observe the amount of current used and the power required and to get all the information we can which will be available for public use when we get through. I might add that our theoretical investigations convinced us that with the number of cells that can easily be put under the seats of an ordinary 16-foot street car, we can run the car something like fifty miles with one charge of the battery, thus enabling us to do a full day's work of 16 to 18 hours by changing the batteries once at midday. This, I hope, we shall be able to do, and I shall be very glad to report the results of the experiment at some future meeting. (Applause.)

Mr. E. P. THOMPSON remarked that the success of a scheme often depends not only upon the device itself, but upon the man who has the device in charge, and sketched the career of Mr. E. P. Roberts, a graduate of the Stevens Institute of Technology, as one of constant application to work, and of rise in the profession.

Prof. W. A. Anthony, of Cornell University, then read the following paper:

ON THE DIFFERING TEMPERATURE COEFFICIENTS OF THE DIFFERENT COILS OF A FINE RHEOSTAT.

The title of this paper should rather have been "A Description of Experiments by which the Differing Temperature Coefficients of the Coils of a Fine Rheostat were Discovered." I thought the experiments of sufficient interest to warrant a description, and I find, on writing the paper, that the experiments occupy the greater part of it.

In 1884 the Cornell University ordered of Latimer Clark, Muirhead & Co., of London, a fine rheostat and bridge of special construction. Among other things it was specified that the resistances of the coils of both bridge and rheostat should check among themselves to 1-100th of one per cent., and that everything should be done to make the instrument as accurate and reliable as it was possible for such an instrument to be. On its arrival it was found not to fulfill the requirements as regards accuracy, the coils differing among themselves in many cases by more than 1-10th of one per cent. It was returned to the makers for readjustment and did not come back to the University for several months. On its return it was found that the adjustments had been much improved, but still did not come within 1-100th of one per cent. It was, however, finally accepted at a reduced price, the writer proposing himself to perfect the adjustment. Press of other work prevented this being done, and, last November, when a problem requiring the highest attainable accuracy in the comparison of two resistances presented itself for solution, this rheostat was used for making the comparison, it being proposed to afterward determine and apply the corrections for the errors of the individual coils.

The problem was, to find by experiment the ratio of the constants of the suspended and stationary coils of the

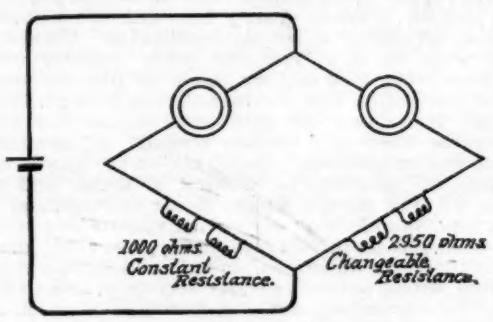


FIG. 1.

large galvanometer, a description of which has already been read before the Institute. The constants of these coils were determined by measurement while they were being wound and the experimental determination of the ratio was undertaken as a check on the measurements. To determine this ratio, a current is made to divide between the stationary coils on the one hand, and the suspended coil on the other, but in the reverse direction, so that the two currents shall have a differential effect on the needle. The resistances are then adjusted till the needle is unaffected when the current in both branches is reversed. The constants of the coils in the two branches are then directly proportional to the currents flowing, and, therefore, inversely proportional to the resistances of the two circuits.

To obtain the ratio of these resistances, they were arranged as two branches of a Wheatstone's bridge, as shown in Fig. 1, the other two branches being made up from the rheostat referred to above. The apparatus was arranged and the tests made by Mr. Ryan, a senior in electrical engineering, and Mr. Hammon, a graduate student of electrical science.

The first trials showed that nothing could be done with binding-screw connections and sliding contacts. All permanent connections were therefore soldered, and all others made with mercury. After this was done, irregularities still existed which were traced to varying temperatures, resulting from the fact that the building in which the galvanometer is mounted is of wood and warmed by a wood fire in an "air-tight" stove. The fire was allowed to go out, and the work continued at the temperature existing outside, about zero centigrade. Times for the experiments were chosen when the temperature was quite uniform, and the results were found to agree very well among themselves, but, to our surprise, they were totally different from the results obtained at the higher temperatures. The table below will show how the results ran.

—Room warmed.—		——— No fire in room.———		
Temp.	Ratio.		Temp.	Ratio.
21.4	2.9520	Dec. 7	1.7	2.9492
21.3	2.9523		1.7	2.9492
20.8	2.9529		1.8	2.9492
20.3	2.9524		1.6	2.9492
20.2	2.9526	Dec. 8	3.7	2.9495
20.2	2.9528		3.8	2.9498
19.1	2.9529		3.8	2.9497
			3.8	2.9497
			etc.	etc.

Here is a difference of one-tenth per cent. for a change of temperature of about 20 degrees centigrade. It should have been stated that the ratios above are the ratios of the two resistances as read from the rheostat; that one of the resistances was always 1,000, and of the other, which was nearly 3,000, only the units and tenths coils were changed.

A study of the construction of the galvanometer, and a discussion of the effects of temperature upon it, made it clear that the change indicated above could not be a real change in the ratio of the constants of the coils. It must, therefore, be looked for in the rheostat. To test this conclusion, different sets of rheostat coils were used in making up the arms of the balance, and tried at high and low temperatures. In one case the ratio was apparently larger at the lower temperature, the reverse of the result shown in the tables above. But the crucial test was suggested and tried by Mr. Ryan. He took the rheostat out of doors and then subjected the galvanometer and all accessory apparatus, except the rheostat, to changes of temperature. The rheostat then indicated the same apparent ratio for all temperatures of the galvanometer.

It is certain, therefore, that a change of temperature of 20 degrees causes a change in the relative resistances of two sets of coils in this rheostat to the extent of $\frac{1}{10}$th of one per cent.; that is, the temperature coefficients of the different coils are not the same, and it is, therefore, no wonder that the makers could not adjust the resistances more accurately. Such differences of temperature coefficients might well occur if the wire of which the coils are wound was taken haphazard from different lots, made, perhaps, from different lots of metal. If makers of fine instruments are not careful to select wire that is sure to be of one composition for the construction of resistance coils, it is no wonder that it is so difficult to attain to a high standard of accuracy in electrical measurements.

But there is another possible explanation for the differences found in this instrument. The low resistances are of coarse wire, and this, from different temper or from different treatment in drawing, might not have the same coefficient, although made from the same metal, as the fine wire. In short, I believe that, for the construction of an accurate rheostat, the coils should not only be from the same lot of metal, but should all be drawn to the same size and subjected to the same treatment while being drawn. The wire chosen should be fine enough for the coils of highest resistance, and coils of low resistance should be made by winding two or more of the same wires in multiple arc.

Mr. FRANK L. POPE: I would like to ask if Prof. Anthony knows of any experiments of that kind that have ever been made with American wire, and whether the same discrepancy is observable there.

Prof. ANTHONY: I don't know of any such experiments. It is our purpose to make an investigation of this sort; but this is all I have to report in regard to the matter at present.

Mr. G. B. PRESCOTT, JR.: Professor Anthony states that the wire in this rheostat was of different sizes. Now, if the current passing through this wire was of the same strength in all the different coils, the tendency would be to heat the thin coils more than the thick coils, and, I suppose, that would need to be eliminated.

Prof. ANTHONY: In regard to that, the current was not sufficient to heat the coils anyway. I suppose the current would not have heated the coils $\frac{1}{100}$ of a degree.

Mr. PRESCOTT: Some two or three years ago Mr. Edward Weston, with whom I am engaged, was making some fine measuring apparatus, and he found very great difficulty in getting german silver wire at different times that was of a uniform quality. For that purpose he made some experiments on his own account to determine just the nature of this variation and what caused it. What led to his immediately taking up the subject was a paper published a short time previously in England by Professor Bottomley, who reported the discovery by some Cheshire man of a new alloy which he called platinoid. He said this alloy was ordinary German silver with one or two per cent. of tungsten added. He showed by some tests that its specific resistance was very much higher and its temperature coefficient very much smaller than german silver. I looked at his original paper, and I could not find what the proportions of the german silver alloy were. I had searched through all the works previously to this on that subject that I could find, and not one of them gave the proportions of this german silver alloy that they used—not even Matthiessen. For instance, you will find in the ordinary tables in the text books a statement of all the different alloys, in which the proportions of each one are given, until you come to german silver, and there they say "german silver," plain and simple. In this country I went to several of the makers of wire and asked for their proportions, and they seemed to use almost everything. After Mr. Weston had heard of this alloy of tungsten, he thought he would investigate it. He made up some ordinary german silver and put some tungsten into it, and kept on adding it until he got ten per cent., and he found that it did not make any difference. But we found by varying the proportion of the nickel that the resistance could be made almost anything, so that the resistence of the german silver is almost directly proportional to the amount of nickel. The effect of zinc was only that of a diluent; it had a mechanical advantage in making the alloy ductile, so that it could be easily handled. We also found that the temperature coefficient varied inversely; so that the greater the amount of nickel you had, the smaller would be the temperature coefficient. We got results very much higher than had been obtained in England with this alloy called platinoid, which was undoubtedly a german silver alloy with a high percentage of nickel. The temperature coefficient we endeavored to determine, but we met with a difficulty, which was this: We had a bridge, the largest pattern made by Elliott, the best bridge of any ever made, of very large wire and very few contacts. There is only one contact for a series of plugs. It is called the "dial pattern." We tried to get the temperature of the room very even, and we got some very curious results. We found that the temperature coefficient was in the reverse direction. It decreased apparently after a certain point. But as we never could be certain of the temperature coefficient of our bridge, we were compelled to abandon determining what the exact coefficient of the wire was; but that question of the proportion of nickel increasing the resistance and decreasing the temperature coefficient we proved beyond doubt.

Mr. MAILLOUX: I think it would be of interest to have Mr. Prescott state what is the largest specific resistance he attained with various proportions of nickel.

Mr. PRESCOTT: In the Western Union Telegraph Company they have a peculiar way of giving specific resistances. It is a very large unit and it is termed the mile-ohm. It is the weight of a wire a mile long which will give just one ohm resistance, *i. e.*, specifies the weight in pounds of the wire. The ordinary german silver on the market has a specific resistance of 12,000 pounds to the mile ohm; that is to say, a

wire a mile long having one ohm resistance requires 12,000 pounds of metal. We found by using an alloy of something higher than thirty per cent. of nickel that we got a mile ohm of 38,000 pounds—something more than three times the specific resistance of the ordinary german silver on the market. The temperature coefficient, as I said before, was so small that we could not determine whether there was none at all or whether it was in the reverse direction with the apparatus that we had.

Mr. WILLIAM WALLACE: Speaking of german silver, there are all sorts of mixtures on the market, and it does not surprise me at all that you do not get two samples alike. There is another thing. You can take the same mixture and pour it at different heats and get different results from exactly the same mixture. Then you may roll it too much or you may draw it too much, and if you do not anneal it enough, you can pull it apart and you will get all sorts of resistances in that way. German silver is a very uncertain metal to handle. I have made a great many tons of it, and it is very difficult to get two batches alike.

Mr. J. A. POWERS: I can speak very feelingly on the subject of the quality of german silver wire in the construction of the McDonald cut-outs, if you will allow me to be somewhat personal. I find that it is almost impossible for us in making those to get wire that will wind twice alike. We wind it up in bands and with a certain definite number of layers. You are obliged to adhere rigidly to a certain routine in order to produce certain results, and all coils are wound up and measured at the same time, and we find that, do the best we can, we will have more or less variations of the wire. We have been to a good many parties for our wire and have been very careful about the gauge, and more careful about the temper, but it still bothers us all the time to get wire perfectly uniform.

Mr. MAILLOUX: I can add an item of my own experience on the subject. Very recently I had occasion to use some resistance coils made for an electrical railroad signal system, and the manufacturer showed me two bobbins that he had wound; I think that it was intended to use a resistance of 20 ohms and he was to use No. 18 wire to wind it. He showed me a bobbin which was wound with that resistance and another one on which he said he had to take a No. 20 wire in order to get the resistance. He wound it until the bobbin was full with No. 20 wire, and even then he could not get the resistance. I have no doubt there must have been twice the weight of wire, and of a much finer size than on the other bobbin where he did not have the 20 ohms necessary. That would show the great difference of specific resistance of the various samples of german silver as we find them in the market, and it would be very desirable to have researches prosecuted on the subject so as to have some definite understanding arrived at which would guide manufacturers in the making of german silver of standard specific resistance.

Mr. PRESCOTT: I would say the higher the specific resistance and the lower the temperature coefficient, the better adapted the wire is for use in rheostats. The wire can be handled so that it is not too brittle. All the wire that I have has come from the Coe Brass Company, who made it according to specifications.

Capt. O. E. MICHAELIS: I cannot contribute anything to the knowledge on the subject in the way of any investigation in respect to the special matter under discussion. But I would like to call the attention of the Institute to something that has struck me in this discussion, namely, the interdependence of all these investigations; and I want to call the attention of the Institution, for the purpose of getting information, to something that I think has a bearing on this matter. You know the question of winding guns has been a very important one in the last ten or fifteen years, and the subject of the winding tension of wire has a very important part to play in the amount of pressure brought to bear upon the core. Now, it appears to me that in winding these coils that fact should be taken into consideration, for no matter how small a winding tension you must have, when you consider the very small cross section that your wire has, even if you have but an ounce or a pound, or whatever your winding tension is, when you increase that directly with the area of the cross section of your wire you will find when you come to square inches that you have a most enormous winding tension to deal with. Now, in a wire-wound gun, which is, after all, nothing but a large bobbin, we have to take into consideration the resulting pressure due to successive layers. Of course, we generally put a tube in the gun, and the initial pressure on that tube is calculated; but that pressure increases, of course, constantly with the number of windings on it. In this investigation of the amount of pressure we use the ordinary formula in regard to a cylinder subjected to a uniform fluid pressure where the pressure produced at any point—if I recollect right—is equal to the thrust divided by the radius. Now, say you have wound the coil to a certain radius, your successive wires that are brought around it will exert, entirely as a result of the winding tension, a definite amount of pressure on the layers that you have already there. In other words, suppose you have wound your bobbin one-half, you can consider that half-wound bobbin as a new core, and it will be compressed, it will be subjected to a very high pressure, merely as a result of the winding tension of the wire, and I would like to ask some of the gentlemen who have given this matter consideration, whether the effect of that winding tension in producing pressure, and of course consequently changing the mechanical condition of the wire, has been considered in these investigations.

Mr. MAILLOUX: I would submit that in the winding of fine wires, the tension is usually made as slight as is consistent with the proper guidance of the wire in winding. In winding larger wires, dynamos for instance, a great deal of tension is placed upon the wire, and I have seen in practice the effects of that tension, where, by lack of precaution in insulating the core before winding, the inner layer of the wire had become abraded, and sometimes short-circuited with the core, the result of the pressure which follows the superposition of the various layers. I do not think that the tension would figure in small coils, though I think it might have some influence on large wires; but as the increment or decrement of resistance would be so slight, it would probably be neglected in dynamo machinery and other machinery where large wire is used.

Mr. G. A. HAMILTON: I might say in respect to what Capt. Michaelis says, that a report was published in the *Philosophical Magazine* three or four years ago, where the writer had taken quite a number of different wires and made his resistances both before and after they were wound, and the differences were quite considerable. I have recognized, though, for a long time, this point of temperature coefficient for the wire, and a number of years ago, in ordering wires for coils, I specified that the wires should be of the same quality all the way through, so that I should be sure of the temperature coefficient. I also think that the suggestion of Professor Anthony, that the wires should be drawn of the same size, is a very good one in winding wires that are liable to have heavy currents in multiple arc.

Prof. ANTHONY: My suggestion is that it would be important in making fine instruments of this sort, not only to use german silver from the same batch, but to take the wire all of the same lot, of the same size, that had been drawn at the same time, and subjected to the same pressure throughout, from the time the metal was melted until it was finally wound up in wire and covered and wound up on the coil, and then to use several of those wires in multiple arc.

Prof. ELIHU THOMSON: It occurs to me that this point might be touched—whether in bending a large wire there is not more mechanical energy expended and a hardening or change of the molecules of the large wire since it is wound on the same diameter as the smaller wire in making the coil. We will assume that we have a wire of a certain diameter and compare it with a wire of much smaller diameter. Now in going around a certain arc, the metal on the half of the wire toward the centre will be compressed, while that on the exterior will be expanded, and the amount of compression and expansion, with a certain radius of winding, will be of course much greater in a coarse coil than in a coil of fine wire. This may have some influence perhaps on the point under discussion.

Mr. MAILLOUX: I have myself noticed, although I have not the resources of a physical laboratory at my command, that a wire that has been wound and unwound several times has a difference in resistance, especially if it is in large lengths, and I thought at first that I was mistaken, but with very careful measurement I found that there was a slight difference between the two, and I cannot find it to be due to any other cause except some molecular disturbance in the wire.

Prof. THOMSON: Take a piece of metal and bend it on edge, and then bend it on the flat, and it seems to me by that means we would arrive at the fact or not of there being a change of resistance produced by bending flatwise and on edge.

Mr. DUGALD JACKSON, of Cornell University, then read the following paper on

THE RELATION BETWEEN THE CROSS SECTION OF THE IRON IN ARMATURE AND FIELD OF THT GRAMME DYNAMO.

The relation between the cross section of iron in the armature core to that in the magnet limbs in a dynamo machine is an important one. On its proper adjustment, in an otherwise well-designed machine, depends the attainment of maximum efficient output per pound of wire with minimum of iron. Of two machines designed for a given purpose, the one with a Siemens armature and the other with a Gramme ring, the path of the lines of force through the armature of the latter machine will usually be considerably longer than in that of the other. It is evident that special care should be exercised to make the Gramme armature of sufficient area of cross section that its magnetic resistance be not increased unduly. Siemens armatures from mechanical principles call for a goodly amount of iron, while an increase of cross section in a Gramme armature increases mechanical difficulties considerably. Consequently Gramme armatures usually have considerably smaller cross-section than Siemens armatures in machines intended for a similar use, magnetic conductivity being sacrificed for mechanical convenience in the Gramme. How far this sacrifice may be carried without impairing the value of the machine must of necessity be specially determined for each individual case.

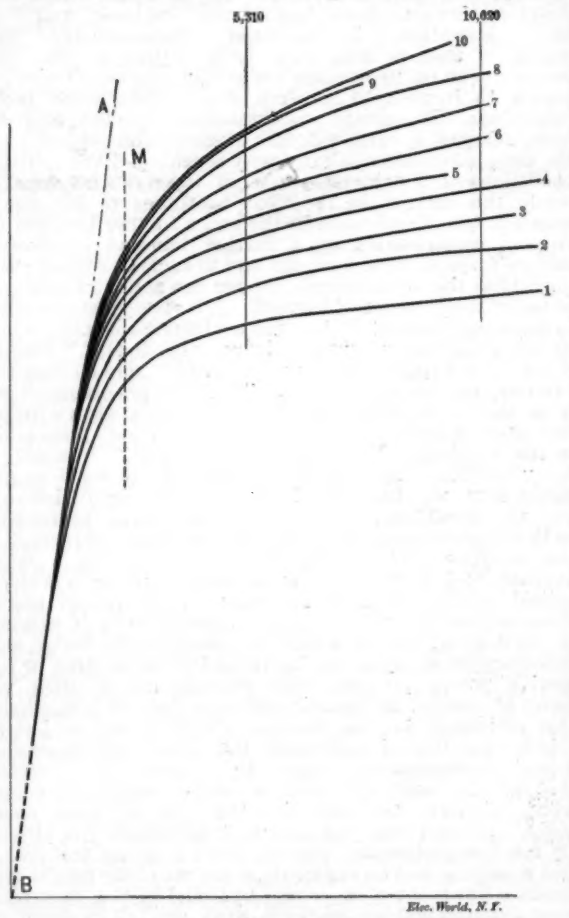


FIG. 1.

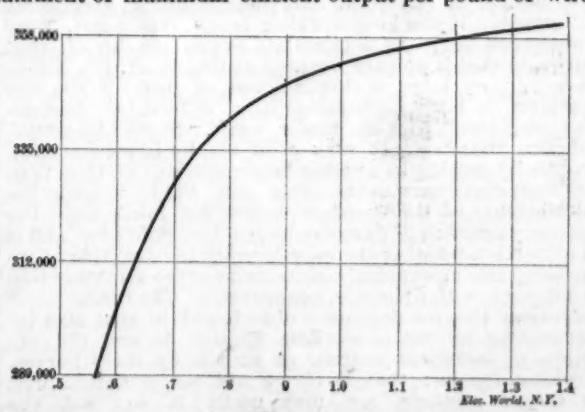


FIG. 2.

The question of how far the characteristic, and so the output of a machine, is influenced by variations in the cross section of the amature could be determined by Hopkinson's very beautiful method of predetermining characteristics. In a machine, the outline and dimensions of which are determined by conditions imposed, the curves of magnetization, such as Dr. Hopkinson used, would be fixed for the field and air space. By plotting curves for amatures of various cross section, the area giving the best characteristic, and yet not unduly decreasing the internal diameter of the ring, would be evident. The value of the leakage ratio v, might be estimated by Prof. George Forbes' method, if the shape of the diagrams were not too complicated.

An experimental solution of the problem for a little dynamo was made this term in the Physical Laboratory at Cornell University. If we had armatures for one dynamo made with cores of various cross sections, the best section would be apparent from the characteristics. However, it is not necessary to wind the armatures, but simply to measure the number of lines of force passing through the armature for various magnetizing forces—that is, observing the data for a curve of magnetization. This may be done in several ways.

In the experiment referred to, a single turn of wire was placed around the section of the armature core perpendicular to the direction of the lines of force. This was connected with a ballistic galvanometer. The swing of the needle of the galvanometer was observed when the current was reversed in the magnetizing coils on the field. The swing was thus proportional to $2\,H\,A$; A being the area of the turn of wire, and H the induction per unit area. Knowing the magnetizing current and the corresponding swing for a number of points for each of several different armatures, the corresponding curve of magnetization may be plotted. These curves are exactly similar to the total characteristic of a series dynamo or the internal characteristic of a shunt machine.

The field of the little dynamo experimented upon is of the single horseshoe type standing upon the yoke. This is rectangular in cross section. The limbs are cylindrical and are held in place on the yoke with two pins each, the contact surfaces being perfectly plane. The yoke and limbs are of the best Norway iron. The pole pieces are of a very good quality of cast-iron and are chambered to fit the upper ends of the limbs, which enter for a length of 7 cm., making the area of contact considerably greater than the cross section of the limbs. The cross section of the pole pieces is much greater than that of the limbs. The bore of the pole pieces is 10.8 cm. in diameter, there being a gap at the top and bottom subtending an angle at the centre of the bore of 51 deg. The width of the surfaces on either side of the gap is .3 cm. The corners of the pole pieces are all rounded off.

Following are the dimensions:

Limbs (cylindrical).

Length	20.3 cm
Diameter	6.35 "
Area of cross section	31.66 sq. cm.
Distance apart from centre to centre	17.9 cm

Yoke (rectangular).

Length	26.8 cm
Width	8.2 "
Depth	6.9 "
Area of cross section	56.6 sq. cm

Pole pieces.

Height	10.2 cm
Width	10.2 "
Bore	10.8 "
Mean area of cross section	— sq. cm

The magnetizing coils consist of 785 turns on each limb, making a total of 1,570 turns.

The armatures were composed of thin punched discs of soft wrought-iron obtained through the courtesy of Thos. Pray, Jr., of Hartford, Conn. The discs were insulated by dipping them into shellac varnish and then built into armatures by placing them on wooden mandrels turned to fit their internal diameter. The variation in the cross section of the armatures was obtained chiefly by using armatures of the same number of discs, but of different internal diameters. As it was not possible to secure discs with the proper internal diameters to give all the area desired, some of the armatures were composed of fewer discs. In these, thin spaces were left between the discs, and the area inclosed by the exploring coil was slightly greater than that of the iron. The effect of this has been neglected as too small to be appreciable. The areas were obtained by multiplying the thickness of the discs, which was .0462 cm., by the number on the armature.

The magnetizing current was furnished by a number of storage cells. In the circuit of these were placed a tangent galvanometer and the magnetizing coils. A reversing key was so placed in the circuit as to simultaneously reverse the current in the galvanometer and coils. The magnetic induction was measured by a ballistic galvanometer, as already explained. The observations were taken by Mr. F. R. Jones, an engineering student working in the laboratory. The regularity of the curves attest the care with which he carried out the work. I have here a sketch, Fig. 1, of the curves determined by Mr. Jones, which, I think you will agree with me, are very interesting.

The following table gives the areas of the cross section of the armatures and their ratios to the cross section of the magnet limbs:

Armature	No.		Cm		Ratio
"	"	1	17.75	"	0.561
"	"	2	19.23	"	0.607
"	"	3	20.70	"	0.654
"	"	4	22.19	"	0.701
"	"	5	23.66	"	0.747
"	"	6	25.14	"	0.794
"	"	7	27.36	"	0.864
"	"	8	29.18	"	0.922
"	"	9	34.49	"	1.09
"	"	10	42.44	"	1.34

In curve No. 1, where the armature has little more

than half the area of the limb, the turn in the characteristic is sharp and the straight line representing the upper portion of the curve is almost horizontal. The rapid and great increase of magnetic resistance shown by the curve to the right of the line *M* must be due entirely to the saturization of the armature. As the area of the armature increases, the turn in the corresponding characteristics grows into a longer sweep and the upper part of the curve takes an increasing angle with the horizontal. Curves Nos. 9 and 10 are given by armatures greater in cross section than the limb, and though there is a difference in their areas equal to a quarter of the area of the limbs, there is very little difference in the total induction passing through the armature. The curve No. 10 then probably very nearly represents the curve of magnetization of the iron in the field and the air space. The straight line, which constitutes the lower part of the characteristic, being the backbone of the curve, as it were, must very nearly represent the line of magnetic resistance of the air space. By air space I mean the space between the pole piece and armature.

Looking at the curves there, you see the armature No. 1 was highly saturated, or, in other words, had become of enormous magnetic resistance before the permeability of the field began to decrease appreciably. On the other hand, armature No. 9 has increased in magnetic resistance very little up to the point to which the characteristic has been carried, while the field is quite saturated. Between these extremes there are varying degrees of relative saturization of the armature. In curve No. 7, the field and armature are apparently at about equal degrees of saturization throughout. The curve (shown in FIG. 2) illustrates the effect on the total induction through the armature of the ratio of the area of the armature to that of the limbs. As ordinates are plotted total induction through the armatures taken from the characteristics on the section line *M*. The abscissas are ratios of the cross section of the armature to that of the limbs.

This curve is exaggerated in vertical scale so that its character may be more plainly seen. It shows obviously that the induction through the armature increased quite rapidly when the armature core was increased in area from .5 of that of the magnet limbs to about .75 that of the limbs. From .75 to .9 there is still an increase of induction with increase of armature core, though not so good as before, and beyond .9 the increase is of no practical importance.

If the section at *M*, Fig. 1, had been taken farther up the curves, the relative increase of total induction with increase in the area of the larger armature would not have been so marked.

The section at *M* is taken at 2,660 ampère turns; that is, an absolute magnetizing force of 33,420. The absolute total inductions for this magneto-motive force are shown in the curve, Fig. 2. These were determined by comparing the throw of the ballistic galvanometer given by the armature with that given by a standard coil turned through 180 degrees in the horizontal component of the earth's field. The value of the horizontal component at the place of the standard coil was determined by comparison with that in our magnetic observatory by the use of the compensated magnetometer.

We may safely assume that the cross section of the armature should be about .75 of the cross section of the limbs if the wire on the armature is to have the greatest activity without an excessive quantity of iron in the core. By making the cross section of the armature .6 of that of the limbs, a loss of 10 per cent. of the total induction, when the ratio is .75, would be made, and consequently an equal loss in E. M. F. and the output of the machine. This is a case where the permeability of the field magnet is equal, or very nearly equal, to that of the armature. If the permeability of the armature core were greater than that of the field, the area of armature could be a smaller ratio.

No allowance has been made in this for the effect of a current in the armature. That should at any rate be small, except in the case of arc-lighting machines, where a great number of turns of wire are placed on the armature with the purpose of gaining stability in the lights.

The absolute intensity of the magnetic flow per square cm. in the armature was quite high. In armature No. 5, the section of which is practically .75 that of the limbs, an induction of 14,000 per square cm. was given by 2,666 ampère turns. For about 10,000 ampère-turns the induction was 17,000 per square cm. 10,000 ampère turns gave an induction of 11,000 per square cm. through armature No. 10 and about 18,000 in armature No. 1. The latter was increased to nearly 19,000 by 12,500 ampère turns.

The induction per square cm. corresponding to the best conditions in this machine is 14,000 per square cm. This is high for a dynamo. I believe Dr. Hopkinson has placed the figure in the Edison-Hopkinson machine as 8,000, and if true, this is probably seldom exceeded. I am aware that the value apparently reached 20,000 in the Manchester dynamo in Hopkinson's late tests, but that high value can not be given much weight, even though the armature was pretty well saturated. I may be placing the limit entirely too low, as I have a number of records where from 10,000 to 15,000 is claimed, but simple claims are endowed with great uncertainty.

It may be interesting to note the ratio of the areas in two or three dynamos of ordinary size. It is impossible to estimate the area of iron in an armature with wire on it, because of the uncertainty in the space occupied by insulating material between the iron discs. In the record of their late tests the Hopkinsons have given the areas of the armature and magnet limbs in the Edison-Hopkinson and the Manchester dynamos. In the Edison-Hopkinson machine the field had probably nearly the same permeability as that of the armature core. The cross section of the armature was about .8 that of the field, and the field was considerably more saturated than the armature. In the Manchester dynamo the field probably had a lower permeability than the armature, and they were about equally saturated. The cross sections of the Gramme ring in this machine was about .6 that of the cross section of the field.

Mr. S. S. WHEELER: I have arrived at some of the conclusions which are expressed in Mr. Jackson's paper, not exactly by different courses of reasoning, but by different tests. For instance, using a Prony brake pulled up tight to the pulley and a scale to show the pull. The pull in the dynamo is the equivalent of the electromotive force; in fact, in the early stages of dynamo work, some gentlemen whom I know made their electromotive force calculations entirely by the pull. That second curve is extremely interesting and extremely valuable. I understand, without having had enough time to digest thoroughly the important points stated, that that curve represents the effect of making changes in the cross section of the armature; that is to say, as you go to the right hand in the curve the short perpendicular line represents increases in the section of the armature core, compared with the field, and the distance up and down represents (to speak very practically) the benefit derived. The result of the work of my friends and of myself has been that we have pitched our machine at about the point .75.

Professor THOMSON: The subject of dynamo designing is undoubtedly one of very great importance, and I have some few remarks to offer thereon, as I have designed a large number of types of dynamos, and experimented with a considerably greater number. I think that the first thing we should settle in dealing with this subject is the type. What is the machine to do? If you are to run arc lights, your design must be entirely distinct and different from that which you use in running incandescent lights. The reason of that may not at first be so obvious, but if we consider the nature of an arc light we will see it. An electric arc may be running steadily—I speak now, of course, of the long, quiet arc, what may be called the perfectly-developed arc, not a hissing arc (that is a semi-incandescent light, and partakes somewhat of the nature of an incandescent load for the machine)—but a long, well-developed arc with the crater fully exposed, burning quietly, possesses peculiar properties. If it is at a certain condition, 10 ampères and 45 volts, and you increase the current slightly, you may convert that arc into a hissing arc abruptly with a great fall in its resistance. Now what will be the effect, if you have a machine that is worked at its normal current, on the curve of that machine? You will find that the machine is not stable. The current will not stop at 10 ampères if at this point; the current of the field magnets is represented at 10 ampéres in a series dynamo; the current will continue rising until a point is reached on the curve where the electromotive force of the machine either drops, or does not increase by the addition of current in its field magnet or exciting circuit. The consequence is that the successful arc lighting machines depart entirely from such terms as you find here. They go up to a certain point when the normal current is reached. There on the bend a little beyond it the line dips, showing that an increased current drops the electromotive force, and that is the condition of stability in running arc lights. The arc may be burning quietly. That will represent the wide, open arc (illustrating)—and this set of actions begins. You design your machine, we will say, with a large amount of iron in your armature and a large amount in your field; you save all the copper you can; you make what may be called a very excellent type of an efficient machine, and then you put on a circuit of arc lamps. You have calculated the excitation, etc. You expect to work the arc lights steadily. You find on closing the circuit that the carbons go apart; a tremendous roar of current comes through, the arcs draw wide open; suddenly the machine ceases to develop current—down come the carbons, and the same operation is repeated continuously. The reason of that is that you have adjusted your arc lamps to run on 10 ampères while your machine is not adjusted to furnish 10 ampères, and be stable under those conditions. The current is not stable until the field magnets have reached a certain degree of saturation—unless your arc lamp mechanism is extremely sensitive. Even in those conditions—I speak, of course, of the series machines—while the current in the field continues to increase it causes a fall of resistance in the arc, a further increase of current accompanied by a further increase of electromotive force of these currents and to such an extent that, quickly as the arc lamp mechanism can act, it cannot get ahead of the increase of current. It is always behind time in drawing the arcs. It does not act instantaneously, while its effects on the current are always "headed off." Finally there is a rupture of the whole circuit, down come the carbons, and we start again. That is a phenomenon we have met with frequently, and it comes always with an increased amount of iron beyond a certain proportion in the machine. We call it "oscillating," "surging" or "building up" and "dropping down"—rough terms that we have used for the purpose of indicating the condition. It may be interesting to remark in this connection that we tried at one time compounding the machine and endeavoring to work it with a large amount of iron way below saturation, using a derived circuit winding to drop the curve at the proper point. Even in that case there was the same difficulty of surging or oscillation. Now, when we come to the design and construction of dynamos for incandescent lighting or for motive power purposes—the electric motor—then we have, of course, an entirely different state of conditions. Our resistance on the external circuit is not subject to this sudden drop of resistance, but it demands more and more electromotive force to increase the current through it, and we have a dead resistance somewhat similar to this in use on a wire resistance. In that case you can work anywhere you please. On this line (indicating) you can work at about this point; and it may be that an explanation of some of the results Mr. Jackson has pointed out would be found in the fact that most dynamo builders prefer to work pretty low down on the curve. They do not like to buy their magnetism dearly. They would rather put in quantities of iron and diminish the copper in the field magnets, and get their magnetism at a rather low degree of saturation, and you will notice at this point that there is not a very great difference. If you keep working below this point, your differences begin to accumulate as you get up on that curve, so that if you are working at this point, the difference is very large in the amount of iron: if you are working it here (indicating) the differences become less and less. But in motor work, we find by actual practice that we get very good results in constructing motors by putting in a rather larger amount of iron than has been customary in the armature. We have made the permeability of the armature very much lower than the ordinary practice of dynamo design has called for, and it is a question whether the movement in the direction of increasing the mechanical conductivity of the armature iron is not, even with dynamos, a proper step. The limitation of increasing the iron sections will be found in that plan between two conditions working against us, and the condition of increased output, as shown by these curves, working for us; that is, if we use the armature iron in larger sections, we may make it so that the changes of current increase the heat; that is, the Foucault currents may trouble us. And if we make it of larger section also, we increase the length of wire which is to go around it—one turn of wire required to cover the increased section—and those influences may be said to be working against us, so that there will be a point somewhere on this curve at which we will find the maximum conditions. In motor work, our design of course is to pass as much as possible of the magnetism we develop through the armature, and the armature itself assists us in doing that. There seems to be no reason why we should not use a comparatively large section of armature iron in a motor. We develop a field magnetism which we do not wish conducted out into the air, and therefore we give it the best path possible through the armature. The motor would seem to be made of the best design when we have given a very ample section in the armature for the passage of the lines of force.

Mr. MAILLOUX: I would like to ask Mr. Jackson whether his statement is, that seventy five per cent. sectional area is what he considers the best proportion. In my practice, whenever I have used the Gramme ring I have always used a sectional area at least equal to the sectional area of the limb. I did that, not because I apprehended that I needed such a large amount, but because I realized that only a portion of that sectional area can be utilized—employed usefully in conveying lines of force. Some years ago I discussed that question through the press and called attention to what struck me then as a new way of looking at the subject, and it is this; that as the lines of force make the ring their path in passing from one pole to another, it is quite evident that the tendency for lines of force is, like other things in nature, to take the path of least resistance, the shortest path, and, consequently, to crowd each other. Now, it is quite plain to my mind that there must be a condition of lines of force on the periphery of the ring, on the outer surface, different from what there is inside, and, consequently, this must mean an increased resistance of penetration. In other words, the coefficient of permeability must become lower, no matter what the resistance of the iron is, at the point where the lines of force enter into the core, as well as where they emerge from it; so that we might have a core of very great section, and if the magnetic density, so to speak, is very great on the outer surface, then the resistance to further penetration will be so far reduced that only a portion of the sectional area will be useful in conveying lines of force. I was led to look at this from the fact that a great many builders of Gramme rings have departed from the old method of constructing the core of fine wire wound into a solid annulus, and instead have used laminated rings of more or less thickness and separated from each other at a certain distance. Now I have noticed that although they get much less weight of metal in a given area of section in an armature than would be the case if they used fine wire, yet they seem to obtain very nearly as good results. And it has always been a question in my mind whether the use of laminated rings, leaving a space between, did not afford better opportunities for the lines of force to seek new paths—to enter by the side of each lamina—instead of being forced to enter at the peripery. I know that there is a great deal of diversity of opinion among physicists as to the possibility of a piece of iron being saturated at one part and not magnetized at another part. I remember at the National Electrical Conference in Philadelphia, in 1884, the statement made by Prof. Silvanus P. Thompson was harshly criticised, when he said that the central part of a core might not be magnetized though the outside might be saturated. I do not know on which side of the question to stand, but I am willing to be educated on that subject. I have been told by a maker of dynamos that taking poles of very large sectional area he could take out the central part of it without interfering at all with the nature of the characteristic curves. Those are significant points, and some information on them would be very acceptable.

WEDNESDAY AFTERNOON SESSION.

The secretary read the list of officers elected at the annual meeting.

The PRESIDENT: The first matter on the regular order of business is the very interesting paper and address that will be contributed by Prof. Elihu Thomson, but before we reach that I understand that an important report will be presented, and we will take that up first. Mr. Phelps, as chairman of the committee appointed last night to report at this meeting, will now present his report from the Committee on Permanent Quarters.

Mr. Phelps read the following report:

REPORT OF THE COMMITTEE ON PERMANENT QUARTERS.

To the American Institute of Electrical Engineers:

GENTLEMEN: Your committee appointed to consider and report upon a plan for securing permanent quarters and to estimate the cost of same, offer the following report:

It should be stated, first, that the subject before the committee has been discussed at considerable length during the past week by several officers and members of the Institute active in its work; and that the committee avails itself of much of the suggestion thus brought out, as well as of information elicited by preliminary inquiries on the part of several members as to cost, ways and means.

As a result of inquiry, and consideration of the needs and possible resources of the Institute, your committee recommend that immediate steps be taken toward securing permanent quarters; and it is their judgment that, in view of considerations presented below, the Institute will be justified in moving to purchase a house in this city, in an eligible location, and of sufficient capacity to provide all accommodations that will be required for many years. A dwelling house in a respectable neighborhood, not remote from Union or Madison Square, somewhat similar to that in which we now assemble, through the kind courtesy of the Society of Civil Engineers, could be easily adapted to our purposes.

The committee have made inquiries as to the cost of such a house, and have been assured that a dwelling house, 24 or 25 feet wide, and of three or four stories, can be purchased for $30,000 or less. Three such houses were found upon the list of a single prominent real estate firm.

How shall sufficient money be raised to purchase and maintain such a house?

The committee recommend that a fund of not less than $10,000 be raised by subscription. They have reason to believe that from $3,000 to $5,000 can be obtained from subscriptions of members of the Institute, and that the balance of the $10,000 proposed can, by proper effort, be secured by subscriptions on the part of gentlemen whose fortunes and business have been connected with the development of the electric arts.

It is recommended that all subscriptions be made contingent upon the raising of the sum named, viz.: $10,000.

With such a sum in hand, it is the opinion of the committee that the Institute would be justified in selecting

and purchasing a house. The remainder of the purchase money could be raised on bond or bonds and mortgage at a low rate of interest, probably not greater than 4 per cent.

In respect to the maintenance of a house, it is quite obvious that a large increase will be required in the present revenue of the Institute. This would, in the opinion of the committee, be partly supplied by the increase of membership that would follow the provision of permanent quarters, with increased facilities and privileges. A still larger increase could be provided by increasing the rate of annual dues for resident members, in return for which they would have privileges similar to those of a club.

The fixed charges may be approximately and safely estimated (excluding personal services, custodian, etc.):

Interest, 4 per cent. on $20,000	$800
Taxes, insurance and repairs	1,200
	$2,000

Further charges would depend upon the nature of the accommodation and facilities provided. It seems safe to say that $1,000 could be made to cover such house expenses as would be required for the first year.

The committee by no means recommend limiting the amount proposed to be raised by subscription to $10,000, but consider that it will be within the bounds of prudence to purchase a house when that shall have been reached. They recommend that efforts to secure subscriptions be pressed diligently, and confidently believe that a very large portion, if not the whole, of the sum named ($30,000) can be obtained.

The committee deem the advantages of having permanent quarters of our own so obvious as to require no enumeration on their part, and believe that a concerted effort on the part of the members of the Institute will surely lead to success.

They trust that such action will be initiated at this meeting as will result in the provision of a suitable house, properly fitted for the occupancy of the Institute, at the resumption of its monthly meetings next November.

To that end they advise the passage of a resolution authorizing and directing the council to proceed to obtain subscriptions, perfect plans, and report at a special meeting of the Institute, to be called not later than July 1, next.

(Signed). GEORGE M. PHELPS, JR., Chairman,
T. C. MARTIN,
GEORGE A. HAMILTON.

Mr. PHELPS: What I have read ends the manuscript of the report; the rest will be oral. This thousand dollars just mentioned, with the two thousand dollars fixed charges proposed, represents an expenditure of three thousand dollars a year, and the committee would say further that as we begin modestly we might find it desirable, and we think it would be feasible, to derive some revenue from the house. For example, the basement story might very probably be rented for some business purpose that would not be disagreeable in its nature—possibly for a restaurant of a good class, which would be rather an advantage; and it has also been suggested that the third story of such a building should be fitted up for dormitories, neatly and comfortably furnished, and that it would be used largely by out of town members and their friends at a reasonable charge — say a dollar for a night's lodging; and members have told me to-day that when in town they would be only too happy to find a room of that character at such a house at their disposal for a dollar per night; and it is proper to say further that a considerable number of members have signified their willingness to subscribe within their ability, outright, a sum of money to be donated for this purpose. In view of what has been presented, the committee would recommend the passage of a resolution at this meeting authorizing the council to proceed either by itself or by a committee appointed by it to take this matter in hand at once and to endeavor to raise the $10,000 by subscription, and to report at a special meeting of the Institute, to be called not later than July 1. I believe that is the extent of our work, and in view of the interest that has been expressed at various times within the last three years since the formation of the Institute, and the very manifest advantages of having a place of our own where we can be independent and where we can have abundant accommodations, where we will have room for the starting of a laboratory and for a historical collection and many other similar purposes, all of which will be found useful the moment we have a place, and the additional standing and prestige the Institute will have as soon as it has a habitation of its own, the committee very earnestly recommend the prompt and cordial support of the council in making an earnest effort to carry the movement through. (Applause.)

Mr. SHELBOURNE: I move that the report be accepted.

The motion was seconded by Mr. Wheeler and carried.

The PRESIDENT: Having adopted that report, gentlemen, the next thing in order is to have a resolution presented in the shape suggested by the report. I should be very glad to have that resolution put in formal shape immediately.

Mr. R. W. POPE: I understand that the committee is to go right on with its work. This is merely a preliminary report I presume.

The PRESIDENT: I understand the report to suggest that it be transferred to the council, and that the council summon to its aid all the mind, enthusiasm and weight in the profession to put this thing through.

Mr. FOWLER: I would like to say that at a meeting of the Electric Club this same idea was broached about their securing quarters also, and I think it would be a good idea for our committee to confer with the members of the Electric Club and see if we could amalgamate in some way, so that instead of running two small-sized establishments we could get together and make one large one. I would offer this simply as a suggestion to the committee appointed here.

The PRESIDENT: I think that Mr. Fowler's remarks have our hearty sympathy and support. We move as a national body. This morning the matter was brought up of the amalgamation with the New York Electrical Society, which has an excellent record, and which might desire, in some way, to affiliate with us. I think if we put ourselves on record to-day as willing to undertake this work, we shall receive the immediate assistance of both bodies, and we shall have a home in New York of which all three bodies may be proud. But this movement has been in our hands for three years, and the time has now arrived for us to bring it to a head. I do not think that we can do better than to accept a resolution which, I believe, Mr. Phelps is now about to offer.

Mr. WHEELER: I think it would be well to get our house movement well under way and then to take in the Electric Club and the New York Electrical Society. We need not wait until we get the house, but if we get our movement well under way, as it is evident that it is going to be got under way so that everybody will acknowledge it as a thing sure to be accomplished, then the other societies will be much more easy to manage, and much more glad to join us.

The PRESIDENT: I would like to state to Mr. Fowler that we have had a committee on this subject for three years, and that committee has now fallen into hands that mean business, and we propose to carry this scheme through. Now, should there be any such movement in any of the other bodies, why, all we want is their help. There are no antagonisms; we are here to serve the common cause, and although I am not aware that Mr. Fowler is speaking as a delegate from any other body, we are glad to have his views on that subject, and are glad to have that information from him.

Mr. PHELPS: Before presenting the resolution I might perhaps state that I do not think there is any conflict whatever. The purposes of the Institute and of the Electric Club are very different, but the establishment of such a headquarters as we have in mind would include within its possibilities the satisfaction of a variety of purposes for which there are now two or three societies, and ultimately it is very likely to result in the amalgamation or co-operation of all these societies. But, as has been very properly said, the first thing to do is to get our place, and the council seems to be the proper body to take action of this kind, as it has frequent meetings and embraces all the officers of the society. The following resolution has been prepared:

Resolved, That in view of the report of the Committee on Permanent Quarters, the council be directed to take up the subject and to proceed at once to solicit subscriptions, perfect plans, and to report to a special meeting of the Institute to be called not later than July 1.

My idea in presenting it in that form is that in the next six weeks or thereabouts the subject may be considered by the council; it can use its own methods and appoint a committee or otherwise. Final action ought very properly be made by the Institute as a body, and at any time not later than July 1 we could no doubt secure sufficient attendance to take proper action.

Captain MICHAELIS: In rising to second the motion, I would simply like to say that, aside from the strong grounds already presented in favor of this project, it may be considered in another light, and that is from an ethnological standpoint. Man is a gregarious animal; there is no question about that, and I think that the further we advance in civilization, and the older we get, we find there is a tendency to come together. There is always this tendency to come together and chat and read papers and do some other things that are not at all disagreeable, and I think that we would find a ready response to anything of the kind, provided that the financial part can be arranged. I do not think that, at this early stage of the movement, consolidation with any other body need enter the matter at all. I think that all those things will come together, perhaps. If our interests are the same we can come together; if our interests vary we will not come together. But I think Mr. Phelps' resolution meets the point. As I understand it the idea is to give the council the authority of the Institute to act in its name and do what it may deem best to further it, but the effect of this resolution will be that the Institute, as a body, commits itself to the idea that there shall be permanent quarters acquired in whatever way may be deemed best, and I cordially second the resolution.

Mr. MAILLOUX: I have only a few remarks to make in expressing my assent to the resolution as presented. I wish, perhaps, to say a word of caution by stating that while I am a partisan of aggregation, by all means, and not of amalgamation, in the sense in which it has been used here, I am also a partisan of assimilation and absorption, though not of the kind of absorption that is spoken of. The Institute of Electrical Engineers started three or four years ago with a well-defined purpose, and I believe it is composed of a body of men, some of whom are preeminently fitted to be the head of the profession, not only by their scientific attainments, but by their standing in the community as electricians and electrical engineers. I have only to look around me to see such men as Prof. Anthony, Prof. Elihu Thomson, Mr. Frank L. Pope, Mr. Geo. A. Hamilton and other men who are known to us all in America as electricians.

While I appreciate very much the social element I should dislike very much to see the scientific feature of our institution, which is its foundation, suffer from the introduction of too great a dilution of the social part of it. You all know me, gentlemen, as a practical man—a man whose vocation it is to deal with practical matters; at the same time you all know that I entertain the highest regard for the scientific. I realize that there is not enough of it in this country—that we are not quite as hard students as we should be. Therefore, gentlemen, I say that I am a partisan of aggregation, but I am above all a partisan of assimilation. I am willing that these gentlemen who are interested in electricity because they make money out of it, and are also interested in electricity because they meet very genial people, should join us in social intercourse. And I am also willing that they should come into our body, that we should assimilate them, but I do not look upon our programme for a single moment as one which admits of the proposition for amalgamation with any other body. We have a well-established basis and we have a well defined programme to pursue which was laid out for us by the founders of this institution, many of whom I see before me, and I do not think that the time has yet come, nor do I think that it ever will come, when it will be necessary for us to swerve from that well-defined line of practice and of principle. (Applause.)

Mr. SHELBOURNE: There is just one other aspect of this question which I want to advert to and that is that the Institute was started four years ago started as the American Institute of Electrical Engineers. Now, on the principle that the greater includes the less, an American institute ought to include a New York electrical society or a New York club, and if it comes to a question of absorption, if it comes to a question of uniting under any circumstances or conditions, it would seem appropriate, it would seem the thing to do, that a local organization should come up into the broader and larger organization. This Institute took a position from the first upon the basis of pure electrical science, and it has always been my view that this Institute should be conducted in that spirit and with that motive; that its members or its head should not be associated with any partisan applications of electricity, so as to bring cliques and divisions into this Institute. That has been my view; that has been the motive on which I have acted in connection with this Institute from the beginning. Now, as I understand, the New York Electrical Society has a membership that is engaged in the practical work of the utilization of electricity. I think it would be appropriate that that society should not be amalgamated with this or that we should take the name of the New York Electrical Society or the Electrical Section of the American Institute, or that we should take the name of the New York Electric Club, or anything of that sort; but if there is any amalgamation, so called—which I would rather replace by the word absorption—let the absorption be of the less into the greater, and let that society, or that club, or any other society or club that is connected with electrical matters come into this Institute under the name of the American Institute of Electrical Engineers. (Applause.)

Mr. PHELPS: Pardon me if I seem arbitrary at all, but the question before us is not at all whether we shall take in any other societies or whether they shall come to us. We have much to do this afternoon, we have many interesting papers to read, and I think we are drifting into a discussion that is quite beside the point, important as it may be eventually. The question as I understand it is whether we shall take any step towards securing a building. (VOICES: Question.) There may be much expression of opinion to be given as to the desirability of that proposition.

The PRESIDENT: Mr. Phelps will appreciate my position; I did not wish to head off any discussion.

Mr. FOWLER: My remarks about the Electric Club were made only for the reason that the Electric Club seems to have been the first club of the kind to make a movement towards getting permanent quarters.

The PRESIDENT: We have had a committee of the Institute on this subject for three years.

Mr. SHELBOURNE: I simply want to beg pardon of the meeting for speaking as I did, because I realize that I was not speaking to the question, but my remarks were called forth by that feature of the subject being opened up.

Mr. R. W. POPE: If Smith wants to buy a house, that is no reason why Jones should not have one to live in as well. There is an old saying that no house is big enough for two families, and I have been through that myself. I say that if we want a house I feel we can have it, and I think that before this meeting is over we will assure these gentlemen that we will start to get it, and if we make the same progress in three months that we will make in three days, we will have a house to move into this fall.

Mr. WHEELER: I think if we go ahead and secure a house it will assist in the process of assimilation instead of absorption.

The PRESIDENT: The question has been called for; I think it is time now to present it. (The President read Mr. Phelps' resolution.)

Mr. R. W. POPE: I have one word to say about that, and that is that the committee should go right ahead without waiting for the council at all.

The PRESIDENT: I shall immediately invite the expression of the members' views upon that subject. I think that clinches it.

Mr. PHELPS: I was about to say, Mr. Chairman, that everybody concerned will immediately proceed with this work, and the council may come together whenever it chooses to take any action that may be deemed necessary at any time. I do not think that the fact that the council does not meet until a month from now need cause any delay.

Capt. MICHAELIS: I think it might be well if it were added to that resolution, in order to give the committee some status, that this resolution carries with it the vote of the Institute that we have quarters. I think it would be better that we passed a resolution to-day that we are pledged to go into permanent quarters. That would give the committee, when they solicited subscriptions, a stronger position.

The PRESIDENT: Suppose we try a resolution of that kind ten minutes hence.

The resolution was carried.

The PRESIDENT: That resolution is before you, and I presume it means something. We have had a committee for three years, and I have been surprised myself to find the unanimity and enthusiasm of the members on the subject. They all seem determined, every one to whom I have spoken and every one to whom the members of the council have spoken, to secure permanent quarters, and that being the case there would seem to be no alternative but to take steps in that direction. If others come with us, well and good; if not, we move on ourselves. We have the support of leading members of other societies of whose presence we are proud. We have here Mr. Pendleton, president of the New York Electrical Society. (Applause.) Shall this resolution fall to the ground to-day, or shall we move on? I stand ready to receive any subscriptions to the list that may be now opened.

Mr. W. J. JOHNSTON: Mr. President and gentlemen, I think that we should go right on with that resolution now. We are all working together for the same object; we do it perhaps in different ways; one invents and another introduces apparatus and another chronicles what they are doing. There is no question, I think, in the mind of anybody who understands the subject, that this Institute ought to have permanent quarters. It seems to me as if it would give it a standing that it has not now either in its own country or abroad. I think that there ought to be a tangible reason, if you put the fact of your being a member of this institution to your name, by which it should mean something. I am very much pleased with these quarters that the Society of Civil Engineers have. I do not see why we should not have just as good. There is nothing that would give me more pleasure than to help along a thing of this kind and I take great pleasure in leading off with five hundred dollars. (Applause.)

Mr. FRANK L. POPE: Mr. Johnston talks business. I will take great pleasure in adding to that, on behalf of the firm I represent, the sum of two hundred and fifty dollars to start with. (Applause.)

Mr. PHELPS: I took the liberty two days ago, when several gentlemen were talking this matter and trying to be prepared to do something substantially, of communicating with our very good friend and associate, Mr. J. Frank Morrison, of Baltimore, president of the National Electric Light Association. I addressed him a letter stating to him that we were thinking of doing something of this kind, and that we would be glad to receive a telegram from him the following day, stating what we might put him down for. I received a telegram in reply asking me to put him down for two hundred dollars to start with. (Applause.)

Mr. WHEELER: I have not had but since ten o'clock last night to see what I could do, but I will contribute one hundred dollars from our company. We will give more, but I have not had time to talk it over. I will give that amount, however, on my own responsibility. (Applause.)

Mr. PHELPS: I might say, Mr. Chairman, that I can tender on the part of my father one hundred dollars, and on the part of myself one hundred dollars. (Applause.)

The PRESIDENT: The president is not a moneyed man, but he has the interests of the Institute and electrical science at heart, and he wishes to put his name down for a hundred dollars, with liberty to increase.

Mr. R. W. POPE: The treasurer has been heard from. I intended to speak with the gentlemen with whom I am associated, Mr. C. B. Hotchkiss, representing A. G. Day, who, as you all know, has been making insulated wire for twenty-five years, and I presume when the proper time comes he will do at least what I do, and I feel an intense interest in this as a kind of stimulus to the work of the secretary. The secretary has to do a good deal of work, and it is "rather-hard sledding" when he is not supported, and in order to help the thing along, I want to put myself abreast of the president and treasurer at least, and you can put me down for a hundred dollars. (Applause.)

Mr. WETZLER: Mr. President, I would like to contribute my little mite of a hundred dollars. (Applause.)

Prof. ELIHU THOMSON said it gave him pleasure to add $100.

The PRESIDENT: It seems to me, gentlemen, that we are getting a pretty good expression of feeling on this subject. We evidently mean business I might say that I have information from Mr. Clarence E. Stump, that he wishes to put in to the extent of a hundred dollars.

Mr. PHELPS: That seems to make about $1,650 so far. We said, I think, in our report, that we thought the Association itself would raise somewhere from three to five thousand dollars, so we seem to have got half-way to the minimum now.

The PRESIDENT: There are some members perhaps who may not feel at present that they can contribute to such an extent. It seems to me that we shall easily reach the limit that Mr. Phelps appears to have fixed. I shall be very glad to hear any expression of sentiment that, while it may not reach the extent of a hundred dollars, yet shows full support and sympathy with the movement.

Mr. FRANK L. POPE: I think, Mr. President, that we may feel that the more money we raise in the society the greater amount we can get outside. People always are more willing to help those who show a disposition to help themselves. I think we shall have very little trouble in raising the rest of it. It seems to me, Captain Michaelis, that your motion would now be in order—that we get a house. (Laughter.) Our good friend, Mr. Bogart, has gone through just this experience.

Professor ANTHONY: I have been waiting for the hundred dollar men to get through. College professors, perhaps, cannot be expected to go so far as men who are working commercially, but I will be glad to put in fifty dollars. (Applause.)

The PRESIDENT: I think that college professors are the poorest paid class of men in this country considering what they do to promote our best interests, and I regard that as a noble contribution, and one which will be appreciated by the Institute to the full. (Applause.)

Captain MICHAELIS: I am an army officer and cannot do quite as well as a college professor, but I received a note from eight little Michaelises and they each said they would give me two dollars and a half apiece towards this movement. (Laughter and applause.)

The PRESIDENT: Do you wish to make the motion you spoke of, Capt. Michaelis?

Capt. MICHAELIS: I think, Mr. President, that the Institute has already expressed itself very decidedly on the matter, and I do not think any further motion will be necessary.

The PRESIDENT: The business of the afternoon, in succession to the business already accomplished, is to take up first some very interesting phenomena, which will be brought to our notice by Prof. Elihu Thomson, on alternating currents. We all listen to the Professor with the utmost interest and pleasure whenever he has an opportunity to address us. I am sure that the present occasion will be one of extreme pleasure and profit.

Prof. Elihu Thomson then read the following paper:

NOVEL PHENOMENA OF ALTERNATING CURRENTS.

The actions produced and producible by the agency of alternating currents of considerable energy, are assuming greater importance in the electric arts. I mean, of course,

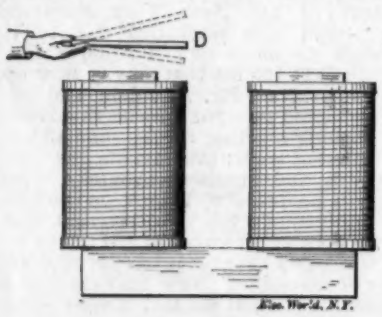


FIG. 1.

by the term alternating currents, currents of electricity reversed at frequent intervals, so that a positive flow is succeeded by a negative flow, and that again by a positive flow, such reversals occurring many times in a second, so that the curve of current or of electromotive force will, if plotted, be a wave line, the amplitude of which is the arithmetical sum of the positive and negative maxima of current or electromotive force, as the case may be, while a horizontal middle line joins the zero points of current or electromotive force.

It is well known that such a current passing in a coil or conductor laid parallel with, or in inductive relation to a second coil or conductor, will induce in the second conductor, if on open circuit, alternating electromotive forces, and that if its terminals be closed or joined, alternating currents of the same rhythm, period or pitch, will circulate in the second conductor. This is the action occurring in any induction coil whose primary wire is traversed by alternating currents, and whose secondary wire is closed either upon itself directly or through a resistance. What I desire to draw attention to in the present paper are the mechanical actions of attraction and repulsion which will be exhibited between the two conductors, and the novel results which may be obtained by modifications in the relative dispositions of the two conductors.

In 1884, while preparing for the International Electrical Exhibition at Philadelphia, we had occasion to construct a large electro-magnet, the cores of which were about six

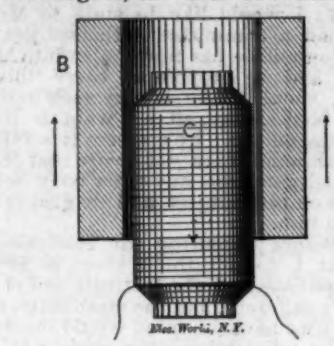


FIG. 2.

inches in diameter and about twenty inches long. They were made of bundles of iron rod of about $\frac{5}{16}$ inch diameter. When complete the magnet was energized by the current of a dynamo giving continuous currents, and it exhibited the usual powerful magnetic effects. It was found also that a disc of sheet copper, of about $\frac{1}{16}$ inch thickness and 10 inches in diameter, if dropped flat against a

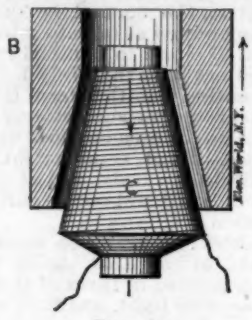


FIG. 3.

pole of the magnet, would settle down softly upon it, being retarded by the development of currents in the disc due to its movement in a strong magnetic field, and which currents were of opposite direction to those in the coils of the magnet. In fact, it was impossible to strike the magnet pole a sharp blow with the disc even when the attempt was made by holding one edge of

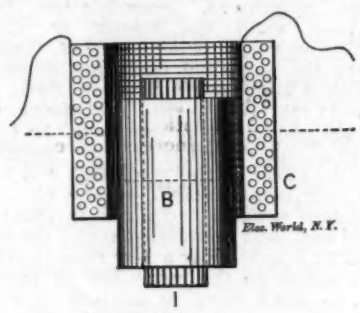


FIG. 4.

the disc in the hand and bringing it down forcibly towards the magnet. In attempting to raise the disc quickly off the pole, a similar but opposite action of resistance to movement took place, showing the development of currents in the same direction to those in the coils of the magnet, and which currents, of course, would cause attraction as a result.

The experiment was, however, varied, as in Fig. 1. The

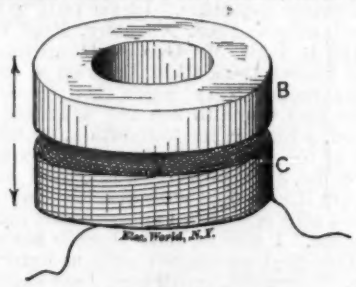


FIG. 5.

disc *D* was held over the magnet pole, as shown, and the current in the magnet coils cut off by shunting them. There was felt an attraction of the disc or a dip toward the pole. The current was then put on by opening the shunting switch and a repulsive action or lift of the disc was felt. The actions just described are what would be expected in such a case, for when attraction took place,

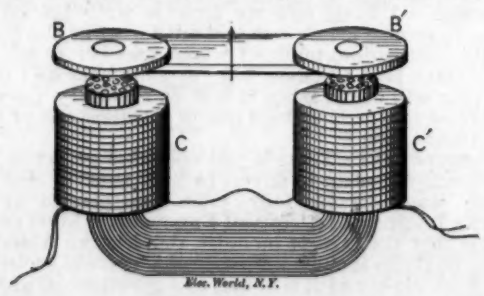


FIG. 6.

currents had been induced in the disc *D* in the same direction as those in the magnet coils beneath it, and when repulsion took place, the induced current in the disc was of opposite character or direction to that in the coils.

Now let us imagine the current in the magnet coils to be not only cut off, but reversed back and forth. For the reasons just given we will find that the disc *D* is attracted and repelled alternately; for, whenever the currents induced in it are of the same direction with those in the inducing, or magnet coil, attraction will ensue, and when they are opposite in direction, repulsion will be produced. Moreover, the repulsion will be produced when the current in the magnet coil is rising to a maximum in either direction, and attraction will be the result when the current of either direction is falling to zero, since in the former case opposite currents are induced in the disc *D* in accordance with well-known laws; and in the latter case currents of the same direction will exist in the disc *D* and the magnet coil. The disc might, of course, be replaced by a ring of copper or other good conductor, or by a closed coil of bare or insulated wire, or by a series of discs, rings or coils superposed, and the results would be the same. Thus far, indeed, we have

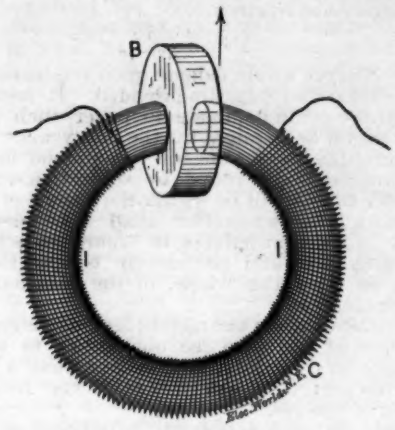


FIG. 7.

nothing of a particularly novel character, and, doubtless, other experimenters have made very similar experiments and noted similar results to those described.

The account just given of the effects produced by alternating currents, while true, is not the whole truth, and just here we may supplement it by the following statements:

An alternating current circuit or coil repels and at-

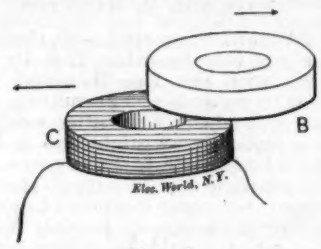


FIG. 8.

tracts a closed circuit or coil placed in direct or magnetic inductive relation therewith; but the repulsive effect is in excess of the attractive effect.

When the closed circuit or coil is so placed, and is of such low resistance metal that a comparatively large current can circulate as an induced current, so as to be subject to a large self-induction, the repulsive far exceeds the attractive effort.

For want of a better name I shall call this excess of re-

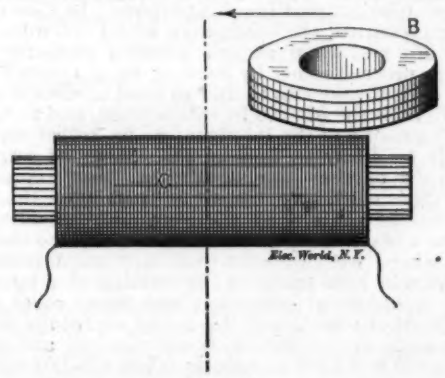


FIG. 9.

pulsive effect the "electro-inductive repulsion" of the coils or circuits.

This preponderating repulsive effect may be utilized or may show its presence by producing movement or pressure in a given direction, by producing angular deflection as of a pivoted body, or by producing continuous rotation with a properly organized structure. Some of the simple devices realizing the conditions, I will now describe.

In Fig. 2 *C* is a coil traversed by alternating currents, *B*

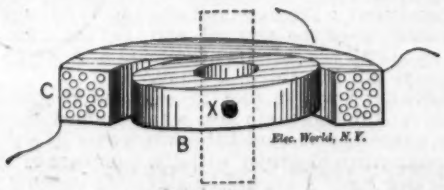


FIG. 10.

is a copper case or tube surrounding it, but not exactly over its centre. The copper tube *B* is fairly massive and is the seat of heavy induced currents. There is a preponderance of repulsive action tending to force the two conductors apart in an axial line. The part *B* may be replaced by concentric tubes slid one in the other, or by a pile of flat rings, or by a closed coil of coarse or fine wire insulated, or not. If the coil *C*, or primary coil, is provided with an iron core such as a bundle of fine iron wires, the effects are greatly increased in intensity and the repulsion with a strong primary current may become quite vigorous, many pounds of thrust being producible by apparatus of quite moderate size.

The forms and relations of the two parts *C* and *B* may be greatly modified with the general result of a preponderence of repulsive action when the alternating currents circulate.

Fig. 3 shows the part *B* of an internally tapered or

coned form, and *C* of an externally coned form, wound on an iron wire bundle *I*. The action in Fig. 2 may be said to be analagous to that of a plain solenoid with its core, except that repulsion, and not attraction, is produced, while that of Fig. 3 is more like the action of tapered or conically wound solenoids and taper cores. Of course it is unnecessary that both be tapered. The effect of such shaping is simply to modify the range of action and the amount of repulsive effort existing at different parts of the range.

In Fig. 4 the arrangement is modified so that the coil *C* is outside, and the closed band or circuit *B* inside and around the core *I*. Electro-inductive repulsion is produced as before.

It will be evident that the repulsive actions will not be mechanically manifested by axial movement or effort, when the electrical middles of the coils or circuits are co-

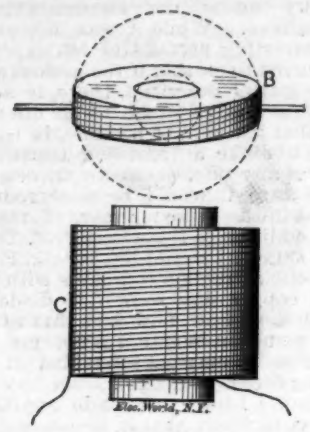


FIG. 11.

incident. In cylindrical coils in which the current is uniformerly distributed through all the parts of the conductor section, what I here term the electrical middle, or the centre of gravity of the ampère turns of the coils, will be the plane at right angles to its axis at its middle, that of *B* and *C* in Fig. 4 being indicated by a dotted line. To repeat, then, when the centres or centre planes of the conductors, Fig. 4, coincide, no indication of electro-inductive repulsion is given, because it is mutually balanced in all directions; but when the coils are displaced, a repulsion is manifested, which reaches a maximum at a position depending on the peculiarities of proportion and distribution of current at any time in the two circuits or conductors.

It is not my purpose now to discuss the ways of determining the distribution of currents and mechanical effects, as that would extend the present paper much beyond its intended limit. The forms and relative arrangement of the two conductors may be greatly varied. In Fig. 5 the parts are of equal diameter, one, *B*, being a closed ring, and the other, *C*, being an annular coil placed parallel thereto, and an iron core or wire bundle placed in the common axis of the two coils increases the repulsive action. *B* may be simply a disc or plate of any form, without greatly affecting the nature of the action produced. It may also be composed of a pile of copper washers or a coil of wire, as before indicated.

An arrangement of parts somewhat analogous to that of a horseshoe electro-magnet and armature is shown in Fig. 6. The alternating current coils *C C'* are wound upon an iron wire bundle bent into U-form, and opposite its poles is placed a pair of thick copper discs *B B'*, which are attracted and repelled, but with an excess of repulsion depending on their form, thickness, etc.

If the iron core takes the form of that shown by *I I*, Fig. 7, such as a cut ring with the coil *C* wound thereon, the insertion of a heavy copper plate *B* into the slot or divided portion of the ring will be opposed by a repulsive effort when alternating currents pass in *C*. This was the first form of device in which I noticed the phenomenon of repulsive preponderance, in question. The tendency is to thrust the plate *B* out of the slot in the ring excepting

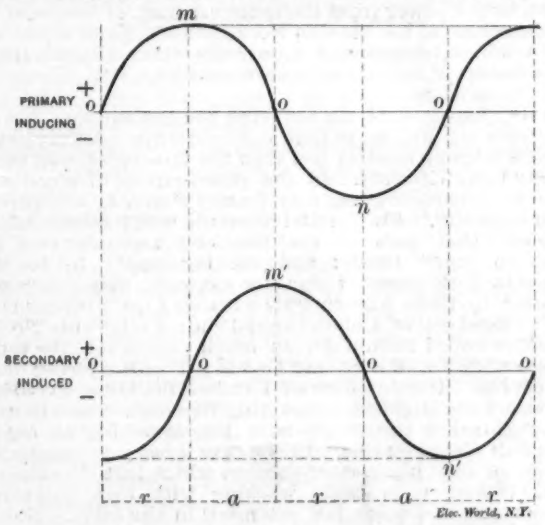


FIG. 12.

only when its centre is coincident with the magnetic axis joining the poles of the ring between which *B* is placed.

If the axes of the conductors, Fig. 5, are not coincident but displaced, as in Fig. 8, then, besides a simple repulsion apart, there is a lateral component or tendency as indicated by the arrows. Akin to this is the experiment illustrated in Fig. 9. Here the closed conductor *B* is placed with its plane at right angles to that of *C*, wound on a wire bundle. The part *B* tends to move toward the centre of the coil *C*, so that its axis will be in the middle plane of *C*, transverse to the core, as indicated by the dotted line. This leads us at once to another class of actions, *i. e.*, deflective actions.

When one of the conductors, as *B*, Fig. 10, composed of a disc, or better, of a pile of thin copper discs, or of a closed coil of wire, is mounted on an axis *X* transverse to the axis of coil *C*, through which coil the alternating current passes, a deflection of *B* to the position indicated by dotted lines will take place, unless the plane of *B* is at the start exactly coincident with that of *C*. If slightly inclined at the start, deflection will be caused as stated. It matters not whether the coil *C* incloses the part *B* or be inclosed by it, or whether the coil *C* be pivoted and *B* fixed, or both be pivoted. In Fig. 11 the coil *C* surrounds an iron wire core and *B* is pivoted above it, as shown. It is deflected, as before, to the position indicated in dotted lines.

It is important to remark here that, in cases where deflection is to be obtained, as in Figs. 10 and 11, *B* had best be made of a pile of thin washers or a closed coil of insulated wire instead of a solid ring. This avoids the lessening of effect which would come from the induction of currents in the ring *B* in other directions than parallel to its circumference.

We will now turn our attention to the explanation of the actions exhibited, and afterwards refer to their possible applications. It may be stated as certainly true that were the induced currents in the closed conductor unaffected by any self induction, the only phenomena exhibited would be alternate equal attractions and repulsions, because currents would be induced in opposite directions to that of the primary current when the latter current was changing from zero to maximum positive or negative current, so producing repulsion; and would be induced in the same direction when changing from maximum positive or negative value to zero, so producing attraction.

This condition can be illustrated by a diagram, Fig. 12. Here the lines of zero current are the horizontal straight lines. The wavy lines represent the variations of current strength in each conductor, the current in one direction being indicated by that portion of the curve above the zero line, and in the other direction by that portion below

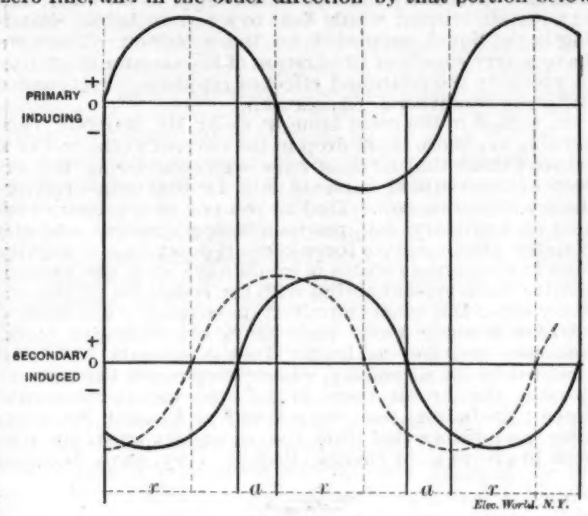


FIG. 13.

it. The vertical dotted lines simply mark off corresponding portions of phase or succession of times.

Here it will be seen that in the positive primary current descending from *m*, its maximum, to the zero line, the secondary current has risen from its zero to m^1, its maximum. Attraction will therefore ensue, for the currents are in the same direction in the two conductors. When the primary current increases from zero to its negative maximum *n*, the positive current in the secondary closed circuit will be decreasing from m^1, its positive maximum, to zero; but, as the currents are in opposite directions, repulsion will occur. These actions of attraction and repulsion will be reproduced continually, there being a repulsion, then an attraction, then a repulsion,

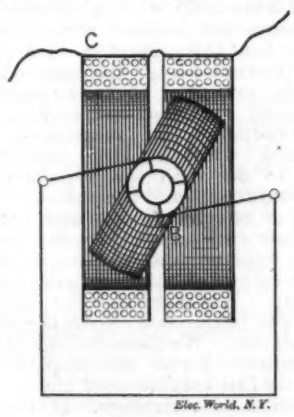


FIG. 14.

and again an attraction, during one complete wave of the primary current. The letters *r*, *a*, at the foot of the diagram, Fig. 12, indicate this succession.

In reality, however, the effects of self induction in causing a lag, shift, or retardation of phase in the secondary current, will considerably modify the results and especially so when the secondary conductor is constructed so as to give to such self induction a large value. In other words, the maxima of the primary or inducing current will no longer be found coincident with the zero points of the secondary currents. The effect will be the same as if the line representing the wave of the secondary current in Fig. 12 had been shifted forward to a greater or less extent. This is indicated in diagram, Fig. 13. It gives doubtless an exaggerated view of the action, though from the effects of repulsion which I have produced I should say it is by no means an unrealizable condition.

It will be noticed that the period during which the currents are opposite, and during which repulsion can take place, is lengthened at the expense of the period during which the currents are in the same direction for attractive action. These differing periods are marked *r*, *a*, etc., or the period during which *repulsion* exists is from the zero of the primary or inducing current to the succeeding zero of the secondary or induced current; and the period during which *attraction* exists is from the zero of the induced current to the zero of inducing current.

But far more important still in giving prominence to the repulsive effect than this difference of effective period, is the fact that during the period of repulsion both the inducing and induced currents have their greatest values, while during the period of attraction the currents are of small amounts comparatively. This condition may be otherwise expressed by saying that the period during which repulsion occurs includes all the maxima of current, while the period of attraction includes no maxima. There is then a *repulsion due to the summative effects of strong opposite currents* for a *lengthened period*, against an *attraction* due to the summative effects of *weak currents* of the *same direction* during a *shortened period*, the resultant effect being a greatly *preponderating* repulsion.

It is now not difficult to understand all the actions before described as obtained with the varied relations of coils, magnetic fields and closed circuits. It will be easily understood, also, that an alternating magnetic field is in all respects the same as an alternating current coil in producing repulsion on the closed conductor, because the repulsions between the two conductors are the result of magnetic repulsions arising from opposing fields produced by the coils when the currents are of opposite directions in them.

Thus far I have applied the repulsive action described in

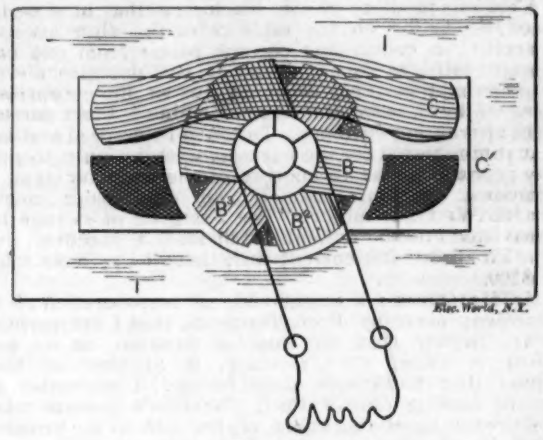


FIG. 15.

the construction of alternating current indicators, alternating current arc lamps, regulating devices for alternating currents, and to rotary motors for such currents. For current indicators, a pivoted or suspended copper band or ring composed of thin washers piled together and insulated from one another and made to carry a pointer or index, has been placed in the axis of a coil conveying alternating currents whose amount or potential is to be indicated. Gravity or a spring is used to bring the index to the zero of a divided scale, at which time the plane of the copper ring or band makes an angle of, say, 15 degrees to 20 degrees with the plane of the coil. This angle is increased by deflection more or less great, according to the current traversing the coil. The instrument can be calibrated for set conditions of use. Time would not permit of a full description of these arrangements as made up to the present.

In arc lamps the magnet for forming the arc can be composed of a closed conductor, a coil for the passage of current, and an iron wire core. The repulsive action upon the closed conductor lifts and regulates the carbons in much the same manner that electro-magnets do when continuous currents are used. The electro-inductive repulsive action has also been applied to regulating devices for alternating currents, with the details of which I cannot now deal.

For the construction of an alternating current motor which can be started from a state of rest the principle has also been applied, and it may here be remarked, that a number of designs of such motors is practicable.

One of the simplest is as follows: The coils *C*, Fig. 14, are traversed by an alternating current and are placed over a coil *B*, mounted upon a horizontal axis, transverse to the axis of the coil *C*. The terminals of the coil *B*, which is wound with insulated wire, are carried to a commutator, the brushes being connected by a wire, as indicated. The commutator is so constructed as to keep the coil *B* on short circuit from the position of coincidence with the plane of *C*, to the

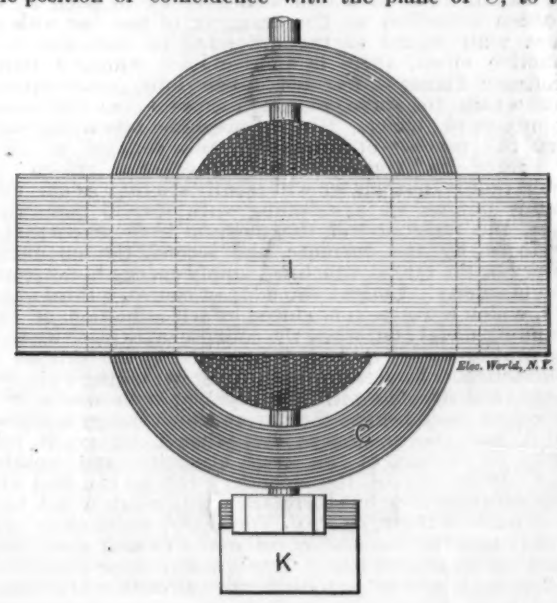


FIG. 16.

position where the plane of *B* is at right angles to that of *C*; and to keep the coil *B* open circuited from the right angled position or thereabouts to the position of parallel or coincident planes. The deflective repulsion exhibited by *B* will, when its circuit is completed by the commutator and brushes, as described, act to place its plane at right angles to that of *C*, but being then open-circuited its momentum carries it to the position just past parallelism, at which moment it is again short-circuited, and so on. It is capable of very rapid rotation, but its energy is small. I have, however, extended the principle to the construction of more complete apparatus. One form has its revolving portion or armature composed of a number of sheet iron discs wound as usual with three coils crossing near the shaft. The commutator is arranged to short-circuit each of these coils in succession, and twice in a revolution, and for a period of 90 degrees of rotation each The field coils surround the armature and there is a laminated iron field structure completing the magnetic cir

cuit. I may say here that surrounding the armature of a dynamo by the field coils, though very recently put forth as a new departure, was described in various Thomson-Houston patents, and to a certain extent all Thomson-Houston machines embody this feature.

Figs. 15 and 16 will give an idea of the construction of the motor referred to. *C C*¹ are the field coils or inducing coils which alone are put into the alternating current circuit. *I I* is a mass of laminated iron, in the interior of which the armature revolves, with its three coils *B*, *B*², *B*³ wound on a core of sheet-iron discs. The commutator short-circuits the armature coils in succession in the proper positions to utilize the repulsive effect set up by the currents which are induced in them by the alternations in the field coils. The motor has no dead point and will start from a state of rest and give out considerable power, but with what economy is not yet known.

A curious property of the machine is that at a certain speed, depending on the rapidity of the alternations in the coil *C*, a continuous current passes from one commutator brush to the other, and it will energize electro-magnets and perform other actions of direct currents. Here we have, then, a means of inducing direct currents from alternating currents. To control the speed and keep it at that required for the purpose, we have only to properly gear the motor to another of the ordinary type for alternating currents, namely, an alternating current dynamo used as a motor. The charging of storage batteries would not be difficult with such a machine, even from an alternating current line, though the losses might be considerable.

Mr. MAILLOUX: I might add, in corroboration of the statement made by Prof. Thomson, that I am perfectly aware myself that the ironclad dynamo, as we have heard it called very recently, is another of those things that have been done before. I remember distinctly reading one of Prof. Thomson's patents where the direct magnetizing effect of the coil on the armature itself is adverted to, and I do not think there can be any dispute as to the fact that it had been brought out before; and I would also state that I myself made experiments with dynamos in which the same thing was made out as early as 1879, and I have small models now which may be of interest at some later time. There is one very interesting feature of it that is mentioned by Prof. Thomson. I think it is the phenomenon which he illustrated by means of his first figure, noting the repulsion and the attraction that takes places when the current is reversed in an ordinary electro-magnet. I could not help thinking, at the time, of some experiments made some years ago by Elphinstone and Vincent, and about which I once took it into my head to write something. The effect was brought out by Elphinstone and Vincent, of the magnetic circuit that we now so well know and use in dynamo-electric machines. I was very much struck by the statement of Faraday in his *Experimental Researches*, where he speaks of lines of force expanding during the action of the beginning of the passage of current through a circuit and of their collapse when the current is discontinued or decreased: and I remember making a note in this article (which you will find somewhere in the London *Electrician*, several years back) of experiments or observations made by me to show that that phenomenon was observable in an ordinary electro magnet. I have been able, by means of a delicately suspended needle, or by a very thin piece of iron wire fastened to the pole—so that it might place itself in the lines of force and follow the oscillations of the lines of force—to trace a positive motion in the lines of force which would exactly correspond to that just referred to by Professor Thomson; in a word, when the electro-magnet is in the process of magnetization, when the current is passing through it, there is an expansion of the lines of force starting apparently from the yoke, and the effect of the motion of these lines of force reacting on the disc would be such exactly as would produce repulsion in accordance with the phenomenon of Lenz's law. On the contrary, there is a collapsing process of the lines of force in the process of demagnetization, and the action would be again such as to produce attraction or the dragging of the disc with it. Now, with regard to the difference of repulsive and attactive effect, there is another fact which I think Professor Thomson has not taken into consideration, and which to some extent increases the difference of repulsive effect. If we assume for a moment that the process of expansion and collapse of lines of force is true—and I have no reason to doubt that it is—then we will readily see that as our current is put on we are dealing with several quantities. First, the resistance of the medium to the stress that is produced by the current; and second, the amount of energy or the rate at which we supply energy to overcome that elasticity. I might also add, of course, a third quantity, which is reaction produced by self-induction of surrounding metal; but when the collapse takes place we have the pent-up energy that has been stored by the process of contraction. I might explain this by taking a piece of rubber and stretching it. The rapidity with which it is stretched depends upon the rate at which energy is applied to it and the elasticity; but when I let go it falls back by virtue of its own elasticity and nothing else. In the case of the secondary coil we can deal with this self-induction, but there are experiments which have been made, I think, by Prof. Von Beetz, which show very clearly that the impulse of collapse is much more rapid than the impulse of rise. Consequently there would be a difference of current in the inductive circuits which would tend, if we follow them carefully by means of the curves produced by Prof. Thomson, to emphasize that difference of action in favor of repulsive process.

Mr. PRESCOTT: Prof. Thomson has so clearly and beautifully described the experiments he has made that he has left hardly anything to be asked. I would say that I am particularly interested in the application to measuring instruments, and I would like to know, whether, in the application he has discovered, the repulsion is inversely proportional to the square of the distance between the plates, and if so, whether he has preferred to make his instruments to measure that distance directly, *i. e.*, based on the distance directly, or whether he has preferred to counterweight, or in some way counteract the movement so as to keep it always constant. He has paid so much attention to this question of alternating currents that I should like to ask him also whether he has ever made any experiments to determine, for instance, whether a secondary battery in the circuit of an alternating current machine would cut off a portion of the electromotive force in one direction which was counter and equal to that of the battery itself, in which case an ordinary current instrument would measure the resistance if connected around the poles of the battery.

Prof. THOMSON: In regard to the measuring instruments, I have used the principle in several ways. The matter has not been carried sufficiently far as yet to determine all the points on the subject, but I have used gravity and a spring in both cases. However, I find there does not seem to be any regular law, perhaps any more than there is with an electro-magnet, for the decrease of the effect by distance, except when the distances become very large. The very fact of a change of position changes the relations of the currents themselves and of the relations between the two currents, so that we can hardly regard the problem as any different from the problem of an electro-magnet attracting its armature. When the armature is placed at a certain distance, there is a certain distribution of magnetism; when it is taken to another distance the distribution is so changed that we could not consider that the centre of gravity, so to speak, of the magnetism, is the same in the two cases, and the re-distribution will depend on the length, the diameter of the core and the sizes of the armatures, so that the problem becomes a very complex one. But I have made a very curious application of the principle in this way: I have taken an ordinary fruit jar and put in it a disc of a certain thickness and attached to it a bulb of glass and floated it in alcohol or water until the gravitational effect was so overcome by the flotation that it was almost indifferent, but it would just settle down to the bottom of the jar (see Fig. 17). I then put an alternating current coil below it and passed a current of gradually increasing amount. Gradually the disc would begin to lift itself, and at a certain current would float to a certain height, standing in the liquid supported by the repulsion. There we have a very excellent illustration of the means of getting at probably the relational effect of repulsive effort under different conditions. (Applause.)

In regard to the point brought up by Mr. Mailloux, concerning the more rapid drop in the current at the end of a wave, I think that he must have been considering the effect of interrupted currents only in that case—the ordinary induction coil. That is, you put on a primary current on a primary coil, put on a battery current and the counter electromotive force keeps it down and it slightly rises to the current which it would have with the electromotive force present acting with the resistance of the primary wire. But when you cut off the current, the secondary current is much more vigorous in electromotive force, but does not last as long. In the primary coil, surrounded by its secondary, when we put on the current or close the circuit there is an opposing electromotive force; the battery does not get its full amount for some time, and during that time the secondary currents will seek to evolve their energy; that is, they have duration

FIG. 17.

without great force. But when we cut the battery current off, and do it specially with a condenser, which enables us to remove the contact without sparking, or, in other words, to cheat the current a little and give it another pass for the time being, the secondary then gives out considerable energy. I may mention an interesting experiment in this connection, showing the effects of self-induction on magnets—a very curious experiment tried with a large magnet. It has not anything to do with the repulsive effect, it has to do with self-induction and the curious effects produced by it in lagging or stopping waves and preventing waves from having their full value. We put this magnet into circuit with the dynamo, and we take a shunt of carbon points—a shunting switch made with carbon as they might be in an arc light. The current comes through this way (illustrating on the blackboard) when the shunting switch is open and goes out. We close the switch, and of course the current gradually leaves the magnet, and gradually it flows in nearly full volume over the carbon points in accordance with their resistance. If their resistance is much less than the magnets all the current will flow over the carbon points. Now, the arc formed here, instead of being a good, strong full arc, will simply be the tops of the waves of the current, while the steady current will flow through the magnet. That is, you will have a steady current in the magnet and the tops of the waves will be chopped off and sent through the carbon. There is no self-induction in this branch and the current there is steady. (Applause.) In fact, the spark you get here and the arc you get there will very closely resemble the spark obtained from the Ruhmkorff coil—a thin spark with a considerable aureola and not very hot. I have drawn them three-quarters of an inch long, playing and sputtering, showing that their waves are having their true value in regard to undulations of sound, whereas an ammeter put in shows a current pretty nearly equal to the line current. (Applause.)

Mr. PRESCOTT: In regard to the secondary battery and the alternating current circuit?

Prof. THOMSON: That is a question that I have not investigated at all, but there would be a current of double volume in one direction and a stoppage in the other direction, provided the volts of counter-electromotive force were right. There is a possibility of producing a current of this character by combination of an alternating current machine and a dynamo and a continuous current machine. We may have a current like that (illustrating) produced, which would be somewhat the current that you were asking about. Whether applications of such currents will ever be made or not I do not know.

Mr. PRESCOTT: The point I wanted to make is a little different. Suppose that an alternating current is passing through that wire (illustrating) and that at this point here we introduce an electromotive force, or we introduce a certain electomotive force in one direction and we have got no resistance in circuit with it, and connect it up *here*. Now, suppose this point be shifted until the difference of potential all in one direction of this alternating current is equal to the electromotive force of this cell *here*; then there will be a current of one direction only through this wire, and if that is the case you have got a known resistance in *here*; you have simply to interpose an electromotive force in one direction and shift it along until you get no deflection in the galvanometer, in which case you could determine, of course, half the electromotive force of the alternating current. Something like this was suggested to me by Mr. John Howell, of the Edison Company, and he wanted me to try it. It is a very recent matter, and I have not had an opportunity of trying it yet.

Mr. JOHN M. PENDLETON: In regard to the secondary battery application that the gentleman has just made I should fancy the result would be the steady discharge of the battery of whatever charge it might have; but it would be impossible to aggregate chemical energy in the battery under the circumstances, I should incline to believe. While I was listening to Prof. Thomson's interesting account of his experiments in the matter, it occurred to me that if the actions are sufficiently delicate in the matter described, there is a great variety of applications, several of which he mentioned, and it appeared to me that it would be possible, in connection with the telephone, to make a recording instrument of that, which might, at any rate, equal the success of the phonograph. In this case it would be a reproduction of the waves of sound in the same manner. I merely make the suggestion in addition to those that Prof. Thomson made.

Mr. CARL HERING: I would like to ask Prof. Thomson how the magnetic attraction compares with its induction. If the closed copper disc were to be made of iron, there would be attraction; now, how does that attraction compare with the repulsion in case it is not magnetic? I ask that in order that we may get some idea of the strength of this repelling force.

Prof. THOMSON: I have not made any determinations with that object in view; that is, to determine the relation as to—as I understand it—the attraction of the magnet coil for its core. I think we can say, however, that it compares very well, only that the copper band of course naturally occupies a greater space and uses energy of current flowing in it. If we have a current flowing in a coil attracting an iron core, and the iron core is thoroughly divided so as to avoid currents in the iron itself, we would get electro-magnetic attraction pure and simple without necessary loss of energy; but in the case of the copper band there is undoubtedly, where large work is being done, a loss of energy due to the flow of heavy currents in the conductor; but in the case of a disc which is deflected, the disc saves itself that loss by throwing itself more or less at right angles. It is only when you are resisting the motion by a counterweight that the loss amounts to a great deal. Allow the thing to move, and it relieves itself of the stress by leaving the point of greatest stress.

Mr. J. A. POWERS: I had a very interesting experience in the line of Prof. Thomson's address about the lag of heavy currents, which I wish to bring to your notice. At Troy we are making an alternating current dynamo, producing direct currents from it; in other words, a simple multipolar dynamo, with this exception, that the armatures are in two layers, the neutral point on one armature corresponding with the maximum point on the other. Those two armatures are connected to a single commutator, there being two bars connected with one armature and the next two bars with the other; the positive of one and the positive of the other; the negative of one and the negative of the other; in that relation, a brush being put on of a certain width we found some curious results. With plating machines of low tension, we found we could increase the width of contact to such an extent that we seemed to collect the entire current from both sides of the armature; in other words, the current seemed to be prolonged from each side of the armature so that we were practically collecting the current from both sides. The moment we got to high tension currents we failed. Without apparent lag of the current, or whatever that was, the minute we increased the tension of currents up to two or three or four hundred volts, we failed entirely. But the point that I wished to bring to your attention was that we could make that contact of considerable width and apparently get a larger power from the same amount of material in the machine in low tension work than we could when we got too high tension, and apparently there existed there this feature of lag of heavy currents which Prof. Thomson first brought up.

Prof. THOMSON: I do not think you can say that heavy currents lag any more than light currents. A heavy current is nothing more or less than the flowing around of so many light currents. In the closed circuit of a coil it is the same current going round many times, as compared, you may say, with parallel currents which represent the current that goes in the fine coil repeated side by side so many times; and the lag ought to be the same in both cases. I find, for example, that it does not matter in these experiments whether I use a copper ring or a closed coil of a finely-wound coil; I might use No. 36 wire, provided I could get as much copper into the same space with No. 36 wire that I could get with a heavy mass of copper. That, of course, I cannot do, but if I could, I have not the slightest doubt that the high electromotive force closed on this would have the same lag as heavy currents closed on this. In one case it has greater length; in the other it has greater volume, which lags the current. Mr. Powers is probably working with high potentials in one case and quite low potentials in the other. Now a high potential machine is a ticklish thing to handle anyhow. You must put your brushes on and carry the coil away not a moment too late or you will have a flash and short circuit of the commutator from one point to the other. I am speaking of the type of machine you refer to. The low potential current, however, permits you to have a considerable variation in the point of connection without provoking bad sparking and flashing; you no doubt need to put the extra overlap of brushes brought on the coils into action at the moment they are developing very low electromotive force, and take them out when they are developing nearly no electromotive force. That you could not do in a machine of that type with high potentials, because if you keep the coils in beyond their time of possessing electromotive force which could just sustain the circuit, you would have a flash; there would be an alternation at the slot in the commutator which would cause a reverse current.

Mr. POWERS: The action I was speaking of was not flashing at the commutator, but the curious "growling" of the machine against itself; for instance, the relation between ten volts and one hundred volts on the same

machine, if you choose to couple them up directly, and the same brushes would give you that slowing down and growling effect, while in the other case the brushes worked smoothly and gave good results.

Owing to the crowded state of our columns we are compelled to defer until next week publication of the other papers read and discussed at the meeting, as follows: A Few Comparative Statistics of Electric Railways, by T. C. Martin; Central Station Construction, by J. A. Powers; On the Change from Negative to Positive of the Temperature Coefficients of Some Carbon Filaments, by Prof. W. A. Anthony, and on Lead-Incased Conductors, by David Brooks.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
NEW YORK, May 24, 1887.

The India Rubber and Gutta-Percha Insulating Company, W. M. Habirshaw, general manager, 159 Front street, has issued a very neat and comprehensive sheet in colors of its electric light leads, of stranded soft copper. The sheet shows sections of the wires, as covered with rubber, in fac simile, and gives also a large amount of useful information as to the diameter, weight, resistance, etc.

The Sprague Electric Railway and Motor Company, 16 and 18 Broad street, is reported by General Manager Harding to be excessively busy. The inrush of new work has necessitated a remodeling of the staff of the company with a large increase in the personnel. Mr. O. T. Crosby, First Lieutenant Engineer Corps, U. S. A., lately stationed at New Orleans on river and harbor work, has resigned, and has entered the active service of the company. Mr. Crosby is not only a good worker but has mathematical ability of high character. Another gentleman joining the company is Lieut. W. D. Greene, who takes the position of assistant consulting engineer. Lieutenant Greene is well known in the Navy for his skill in electrical engineering, and has been engaged on torpedo work at Newport. He begins immediately to superintend the execution of a very heavy contract the company has made. Yet another recruit is Mr. Frank Mansfield, lately engineer in charge of the plant of the Massachusetts Power Company in Boston. He now engages with the Sprague Company to devote himself to railway work, which has already such a tremendous future before it. Mr. Mansfield has had rare opportunities for studying out the problems connected with the electrical transmission of power, and now finds a larger field for the exercise of his talents. The company has also been busy dotting the country with strong responsible agents. Mr. A. H. Chadbourne, the son of the late Paul Chadbourne, President of Amherst College, has accepted the position of manager of the agency in Eastern Pennsylvania, whither he goes with the reputation of the work he has done for the company in this city. Altogether, the Sprague Company is about as busy making a record as it could well be.

I notice that in the advertisement of the New York Safety Steam Power Company is an illustration of their horizontal engine, to a few points of which I drew attention lately. With regard to the governor I would like to note that the speed may be varied at will, either by change in the tension of the one spring employed or by change in the position of the weights, or by both. The direction in which the engine shall run is also easily within control of the engineer.

The Excelsior Electric Company, of Tarrytown, N. Y., have secured a five-year contract, exclusive franchise, for 40 lights there. They are putting in a 100-light plant of the Excelsior (Hochhausen) system. The town committee, made an examination of other plants near by before recommending this. It is said that the fine residences of Messrs. Gould and Jaffray at Tarrytown will be lighted from this plant.

E. P. Hampson & Co. have been very busy lately putting in Armington & Sims engines and other plant for electric lighting. They equipped the above Tarrytown station with four 60 h. p. engines and three 85 h. p. boilers. At Bronxville, N. Y., they have put in a 50 h. p. engine and a 60 h. p. boiler, for the New York Copper Manufacturing Company. At Hempstead, L. I., they have put in for the gas company's Thomson-Houston plant a 45 h. p. engine. At Babylon, L. I., they have put in for the local Thomson-Houston Company a 50 h. p. engine and a 60 h. p. boiler. At Greenport, L. I., for the Greenport Electric Light and Power Company, Thomson-Houston system, they have put in a 50 h. p. engine and a 60 h. p. boiler.

The United States Electrical Company, formerly doing business at 41–43 Wall street, with a branch office in Brooklyn, has been sold out under judgment execution. Mr. W. K. Freeman, of Long Island City, purchased all the property of the company. Mr. Freeman, who is well known in electric lighting circles, intends to stock the store, 529 Fulton street, with all the latest improved electrical apparatus, especially electric light machinery and apparatus. John W. Carter, Sr., J. W. Carter, Jr., and Chas. Carter continue the United States Electrical Company at the old address 289 Fulton St., Brooklyn.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
BOSTON, May 23, 1887.

The Gamewell fire-alarm system has been adopted and extended over the entire town of South Framingham, Mass.

Mr. James Leonard Kimball has been appointed electrician of the New England department of the Julien Electric Company, with office at 104 High street, Boston.

The Erie Telephone statement for the quarter just ended reports a dividend of three-fourths of one per cent., which is said to be earned—above charges for construction. It is stated also, that a large surplus is rapidly accumulating.

The Mexican Telegraph Company earned $5,614 for the week to May 14, and the Central and South American Company $9,629 for the same week, against $3,883 and $7,488 for the respective companies for same period last year.

A dispatch from Gloucester, Mass., under date May 19, reports that Captain McKinney, of schooner "Shiloh," alleges that his vessel, while in latitude 43° 37′, longitude 61° 10′, April 28, fouled the Atlantic telegraph cable, and in order to save the wire from damage cut away the anchor and chain, losing the former and 30 fathoms of the latter.

The Baltimore & Ohio Telegraph Company in this section—particularly in Boston—continues to prosper. Every week during the past quarter has shown a steady increase to the company's business. The recently appointed district superintendent of the telegraph department—Mr. J. W. Larish—has already ingratiated himself in the good opinion of New England business men. Mr. C. J. Sheehan, as manager of the Boston district telegraph service, conducts his department in a very creditable manner, and is daily making new friends for the B. & O. Telegraph Company. Through the indefatiagble labor of Mr. C. S. Jarvis, superintendent of the B. & O.'s district messenger department, the business fraternity at the "Hub" are to-day furnished with a messenger service second to none in the country.

The Mutual District Messenger Company, of Boston, elected officers and directors for the ensuing year on May 21, as follows: Mr. James W. Prendergast, president; Allen S. Weeks, clerk and treasurer, and Messrs. D. J. Hern, Frederick L. Ames, Thomas T. Eckert, Charles A. Tinker, Thomas Roche, Otis Kimball, Parker C. Chandler, James W. Prendergast, and Allen S. Weeks as directors. A report was read at the meeting stating that the company has no debt of any kind; had paid 6½ per cent. in dividends last year, and has a surplus on hand for construction and contingencies.

The Boston *Daily Globe*, May 21, in its financial column, has the following favorable comments on an enterprise already familiar to the readers of THE ELECTRICAL WORLD: A new candidate for favor, which seems likely to be active soon, is the stock of the Lord Acoustic Telephone Company, of which the officers are: John C. Elms, treasurer; Robert Bowles, assistant treasurer, and Messrs. Emery Elms, E. O. Childs, C. E. Wentworth, James Harris, Peter W. French and A. R. Brown, directors. The company has a capital of $250,000—50,000 shares of a par value of $5—is organized under the laws of Maine, and owns or controls something like 20 patents appertaining to mechanical telephony. The peculiar advantage of this invention lies in the fact that it can take the place of speaking tubes in a building and be used as a short distance communication between given points. Undoubtedly in time it will be applicable for long distance telephoning, as the experiments now in progress are most satisfactory, a successful test having been made last week over two miles of wire. The company is prepared to run 500 feet of wire for $25 and an additional fee of 50 cents per month for its use. That the matter is not an experiment is shown from its perfect success in a number of large mercantile establishments. This is the parent company and a large source of revenue will be derived from the sale of rights, to States and Territories, taking, beside one-third of the capital stock of each sub-company, a handsome bonus in cash. Massachusetts, Maine, New Jersey and Rhode Island have already been sold. The office of the company is at 7 Exchange place; it has no liabilities, with a cash balance in the treasury.

Messrs. A. J. Wilkinson & Co., the well-known hardware dealers, of Boston, are making a specialty of a new oil cup for dynamos and high speed machinery of any description, and it is named the improved transparent rival oil cup. The cup is supplied with a patent valve regulator, whereby the valve can be set to allow a flow of one or more drops of oil per minute, and is so constructed that it will never—so it is claimed—work loose from the jar or motion of machinery. This ought to be interesting to superintendents of electric light stations and plants.

The Citizens' Electric Light Company, of East Boston, on Monday, May 16, occupied its new station on the site of the one burned March 4. The new building is of brick, only one story in height, but owing to the conformation of the ground is nearly 30 feet from floor to roof inside. The floor is of massive timbers, the spaces between which are filled solid with coal ashes, planked with two inches of spruce, and crossplanked on top with narrow, hard pine flooring. The roof is supported by heavy trusses of hard pine, and is covered with the best of Easton slate. The boiler room is completely isolated from the engine and dynamo room by brick walls running to the roof, the only communication between the rooms being through a doorway closed by an iron door. The circuits are led into the building through hard pine timbers built into the wall, glass floor insulators being set into the hard pine, and heavy Clark wire running from the outside of the building to the switch-board directly beneath the point of entrance. The plant consists of three American dynamos, two of 50 lights capacity each, and one of 25 lights, belted direct to the engines—one New York Safety Steam Power Company's 60 horse-power, and one Armington & Sim's 50 horse-power—with Charles L. Ivison's patent adjustable link belts. The boiler is of 100 horse-power, made by E. Hodge & Co., of East Boston, and is fed by a Davidson steam pump, through a National feed-water heater. It is set with the Jarvis patent furnace and a mixture of Cumberland coal and screenings is used for fuel. All the appliances are of the most approved modern design, and no finer or more convenient station for the capacity can be found. The switch-board—furnished, as is all the electrical plant, by the American Electric Manufacturing Company, of New York—is a model of compactness and simplicity, and enables the man in charge to handle the circuits with great ease and to make any desired change or combination without stopping the dynamos. This board has recently been fully described and illustrated in THE ELECTRICAL WORLD. This company has a large and prosperous business in East Boston and Chelsea.

Messrs. Goodnow & Wightman, another enterprising Boston firm, also engaged in the hardware line, are supplying the electrical trade and individuals engaged in experimental work with a complete set of castings for small dynamos, including field magnets, armature, bearings for armature and fly wheel, driving wheel, pulley, etc. A complete set of castings in iron and brass, also steel for spindles and the necessary screws and bolts for putting machine together cost only $4.

It is reported that the incandescent electric lights, 450 in number, recently installed in the Hoosac tunnel are giving so much satisfaction to the railway people and the patrons of the Fitchburg road that an order is about to be given for an increase in the number of the lights to 1,750. The Westinghouse alternating or converter system is used. It is stated that the installation of the first lights in the tunnel was a private enterprise of a Mr. Robin, a Pittsfield (Mass.) jeweler. A stock company will soon be organized and the stockholders will include some of the wealthiest and most enterprising business men of Pittsfield.

Some time ago the Malden, Mass., Electric Light Company was given permission by the selectmen of Medford, Mass.—a town only 1½ miles distant from the former—to erect electric light poles with arc lamps, and to run a circuit from its plant into the latter town. The five lights have been burning for the past six weeks on the most prominent thoroughfares in Medford, and although the illuminants are alleged to be only 1,200 candle-power, the people of that town appear to be satisfied. The prediction has been made that at the next town meeting (June 2) the selectmen of Medford will be authorized to contract with the company named for lighting all the streets with electric lights for one year.

Mr. W. T. Mottram, a gentleman of long experience in the electric light field, recently visited Boston, partly on a trip of inspection to the stations and plants in this city, and also on a friendly visit to his old associate and friend, Mr. Wm. J. Hammer, manager of the central station of the Edison Electric Illuminating Company. Mr. Mottram has been, until recently, the superintendent for the Edison Electric Illuminating Company at New Orleans, La., one of the largest of the Edison central stations. He was formerly superintendent for Arnoux, Hochbausen & Co., Wilmington, Del. He was associated with Mr. W. J. Hammer in the electric light business for upward of three years in England and Germany.

W. I. B.

PHILADELPHIA NOTES.

PHILADELPHIA, Pa., May 24, 1887.

The Fort Wayne Jenney Electric Light Company made quite a success last Thursday evening on the Girard College grounds. There are seven towers 125 feet high. Each crib contains five lamps of 2,500 candle-power each. This represents a total of 70,000 candles. An 80 h. p. Corliss engine furnishes the power to two dynamos. The cables are underground. The contract price was $10,750. Quite a number of visitors were present, some of them being parties that expect to spend money in this direction. The installation is a success in every particular, and Mr. Wilbur deserves, and is accorded by all, due credit.

The electrical interests are all prosperous. Supplies are in great demand. A number of large mercantile establishments are figuring on electric lighting. Competition is very close, and margins are gradually declining. The Edgerton people will very soon demonstrate what they can do.

Quite a number of our people are interested in the Welsbach Incandescent Gas Light Company. A good deal has been quietly said about it. Among those who are contributors are Thomas Dolan, John Wanamaker and Wm. M. Singerly. The light, by this process, it is said, costs one-half that of ordinary gas. Various objections to it are raised. Time will show.

The Siemens Lungren Company here held their annual meeting and elected officers for the ensuing year. They are loaded up with orders, they say. Mr. Stone, the president, goes to Europe next week. The Gordon improvement has been purchased by this company, and the "Gordon Lamp" will soon be placed upon the market.

Business is looking up. Several small Eastern Pennsylvania towns are talking electricity.

Electric lights have made over 1,000 gas lamps useless in this city. The question now is, what will be done with them?

Philadelphia expects to make from $1,000,000 to $1,500,000 out of high license, and then spend a good slice of it on electric lights. The exchange will be a good one for the city.

We are to have an elevated road.

D.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
CHICAGO, May 21, 1887.

The North Chicago City Railway Company are now engaged in laying their loop line and putting in the conduit for the new cable road in the business centre. To expedite this work, as it interferes greatly with ordinary traffic, the company has put up, at intervals of about a hundred feet, posts somewhat resembling gibbets in appearance. From each of these posts an electric light is suspended, and by the aid of this light some five hundred men are working every night.

The wires are run from one of the Chicago Arc Light and Power Company's central stations.

H. Ward Leonard and E. M. Izard have formed a partnership, and will carry on a business as consulting and contracting electrical engineers, with offices at 185 Dearborn street, Chicago. Mr. Leonard has been long and favorably known from his services with the Edison Company, as an electrical expert of high standing. Mr. Izard has been associated with Mr. Leonard for more than a year, and is a graduate of the Massachusetts Institute of Technology, Boston, as is also Mr. Leonard. They will give considerable attention to expert work upon dynamos, motors, accumulators, etc. Their announcement, I believe, appears in your advertising columns.

The constant and rapidly increasing business of the Thomson-Houston Company in the West has rendered it necessary for them to enlarge their office facilities in Chicago. Mr. S. A. Barton, the well-known general manager of the company, has now taken up his residence here, and under his able and energetic management an increased volume of business may be looked for.

Messrs. Humbird & Gorton, managers Western Department Edison Light Company, report the following as among some of their latest installations: Columbus, O., central station, 5,000 lights; Kansas City, Mo., central station, 5,000 lights. They have also contracted with the Brush Electric Light and Power Company, of Galveston, Tex., for an incandescent plant of 2,000 lights of 16 candle power each.

The following are the officers and directors of the Chicago Edison Company: A. F. Seeberger, president; J. W. Doane, vice-president; F. S. Gorton, secretary and treasurer; directors, John B. Drake (proprietor of the Grand Pacific Hotel); John Crerar, Robt. T. Lincoln, Edson Keith, A. A. Sprague, P. L. Yoe, Erskine M. Phelps and J. L. Thompson.

The Illinois Secretary of State yesterday issued incorporation papers to the Chicago Electric Club. The objects of the club are

stated to be the diffusion of electrical knowledge, the promotion of social intercourse, and to provide the conveniences of a club house for the members. Among the incorporators are General A. K. Stiles, C. A. Brown, B. E. Sunny, F. S. Terry, Joseph Uhrig, Chas. J. Van Depoele, William J. Buckley, J. P. Barrett, F. G. Beach, Charles D. Shain and W. A. Kreidler. This is the fourth electrical society started in Chicago. This one, however, will not be allowed to die. I shall give you further particulars about it next week.

Mr. W. H. McKinlock, Secretary of the Central Electric Company, 38 and 40 La Salle street, Chicago, says that their business is steadily growing. Amongst their latest orders is one for a 350 call annunciator, guest call and fire alarm, for Plank's Grand Hotel, Mackinaw Island, Mich. The company have just got out a large and handsome catalogue, which they would be glad to send out to those writing for it.

"Chicago is the only city in the United States that has gone earnestly to work putting its telegraph wires under ground," said City Electrician Barrett the other day. "Although many cities have passed ordinances to this effect," continued the official, "the law has not been enforced, and dilatory court proceedings have kept active movements in abeyance. We have made great progress in our city, and expect to have every pole pulled down as far south as Twelfth street before the end of this year. There are now in the central portion of the city but very few poles, and these are standing on Washington and Dearborn streets, with a few on Michigan avenue. The telegraph companies are going ahead faster than the city in burying their wires, and a lack of funds keeps back our part of the work. The city is growing fast, and appropriations have to be used in extending the wires, leaving but a small amount to be applied in this direction. There is about $12,000 to be expended in burying the wires, and we will follow the telephone company to West Madison street in the work. There will also be considerable work done on the North side, and the heaviest wires will be under ground before the end of the summer throughout the entire business portion of the city."

The business of the Western Electric Company was never as good as now. Their Chicago factory is running all day and all night. During the last week they received three multiple switchboard orders One of these boards is for Chicago, with an equipment of 2,400 lines, and a capacity for five or six thousand; another is for Providence, R. I., with an equipment of 1,350 lines, and the third is for Allegheny City, with an equipment for 800 lines. Other orders during the week were 2,000 feet of aerial cable for the Erie Telephone Company; three miles underground cable for Allegheny City, and a large amount of underground cable for Chicago. The St. Louis Western Electric Light Company placed an order during the week increasing their plant 35 lights; and the Roodhouse plant (Western Electric system) started up with great success. A pretty good week for the Western Electric Company I should think.

Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes me the following telephone stock quotations:

Bell of Mo.	$155@$157
Central Union	50@ 51
Chicago	385@ 400
Cumberland	80@ 85
Great Southern	30@ 33
Michigan	76@ 77
Rocky Mountain Bell	40@ 45
Wisconsin	105@ 107

W. A. K.

APPLICATIONS OF POWER.

Richmond, Va.—A contract has been closed by the Sprague Company with the Richmond Union Railway Company to run the road by electricity. The service will include 40 16-foot cars, each equipped with two 7½ h. p. motors, so as to be absolutely free from danger of any break-down. Overhead conductors will be used, and there will be in all about 13 miles of track. The road is to be running this summer, and the work of electric construction has already begun.

BUSINESS NOTICES.

Jordan & Gottfried, 208 Canal St., N. Y., carry a complete stock of iron and brass machine and wood screws, bolts, cap and set screws, taps, dies, files, twist drills, brass and rubber in tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

Philip S. Justice & Co., of Philadelphia, advertise in this issue weldless solid drawn steel tubes, which they believe would meet with favor among electricians if their merits were only known. Those interested should send to Messrs. Justice & Co. for explanatory circular on the subject.

Carbons.—The angry feelings of a good many electric light men were aroused when they heard of the advance in prices of carbons, but now they begin to see that this step was necessary to save the manufacturers from failure. No one could expect that carbon makers, any more than the makers of any other goods, could continue to sell their product at less than cost.

Messrs. W. J. Buck, Son & Co., of Philadelphia, the well-known manufacturers of gas fixtures, have for some time devoted much attention to meeting the growing demand for electric light fixtures. They have a large number of neat, graceful and handsome designs, which it will be to the advantage of electric light superintendents and others desiring this class of fixtures to examine. An advertisement of the firm will be found in another column.

Manufacturing Carbons has been one of the most unsatisfactory branches of electric lighting. Some years ago a good deal of money was made in the business, but it is believed by those who ought to know that, without exception, all of the companies have since sunk in it, not only what money they made, but a larger part of their capital. Still the manufacture of carbons appears to have a fascination for outsiders, and there are plenty who seem to be willing to put their money into the business upon some visionary theory of there being "millions in it."

Mr. E. H. Cadiot, of Paris, the well-known electrician, and the agent for Messrs. Woodhouse & Rawson, advertises in this issue that he is anxious to represent an American firm manufacturing electrical or other machinery. Those who wish such representation will do well to correspond with Mr. Cadiot, who, by the way, has been appointed one of the Commissioners for the Exhibition of 1889. Mr. Cadiot has a thorough knowledge of the English language, and his acquaintance with electricians is such as to render him an excellent representative of an American electrical house.

Electricians would be surprised to know the large quantity of what is called electrical molding and capping used in connection with the running of electrical wires in buildings. The demand for this molding is so great that some of the larger wood-working establishments in this and other cities have separate departments devoted to its production. The New York Lumber and Wood-working Company, of this city, probably does the largest business in this line of any establishment in the country. An advertisement of the company will be found in another part of this issue, from which it will be seen that it also manufactures and sells about everything that is needed in the way of woodwork in house building.

The slight advance in the price of carbons made by some of the companies will, the managers of these companies feel sure, result in a great deal better and more uniform carbon. A few years ago carbons sold at $100 a thousand, and at one time they commanded even a higher price. Owing, however, to the bitte competition among carbon manufacturers, prices kept tumbling until they reached a point where the less business a factory did the more money it made, or, at least, the less it lost. It could not be expected that carbon manufacturers would continue indefinitely to sell carbons below cost. Electric light superintendents have been so used, however, to buying carbons at the ruinously low prices, that they cannot understand why they should now be called upon to pay higher rates. The fact is, however, that for a first-class carbon, one that will give satisfaction both to the superintendent and his customer, the price decided upon by the manufacturers is very reasonable. If the companies by their combined efforts can make a good carbon at a price that will enable them to sell it at a lower price than is now charged, they will be very glad in the protection of their own interests to lower the prices. In the meantime superintendents can depend upon getting from us good carbons, which will be shipped in any quantity on the day the order is received.

Quotations, or any further information, can be obtained by addressing E. C. Hawks, Agent, 90 and 91 Wilshire Building, Cleveland, O.

STOCK QUOTATIONS.

The following list, compiled by Mr. W. H. Baker, member New York Stock Exchange, 16 and 18 Broad street, gives the current quotations of electrical stocks:

May 24, 1887.

TELEGRAPH.	Bid.	Asked.
Am. Dist.	.....	37
Am. Tel. & Cable	75	77
Cen. & So. Am.	96	100
*Com. Tel	.....	.....
*Gold & Stock	.....	.....
*Inter. Ocean Tel.	.....	.....
N. Y. Mutual	81	82
Pac. & Atl.	48	54
*Postal T. & C.	.....	.....
South. & Atl.	68	75
W. U. Tel.	77¼	77⅜
W. U. Scrip	75	.....
W. U. Bonds	117	120
Mut. U. Bonds	86½	87
TELEPHONE.		
Am. Bell	232	233
Am. Speaking	110	120
Erie	32½	33
*Hudson River	.....	60

TELEPHONE.	Bid.	Asked.
Mexican	1⅛	1⅝
*N. Y. & N. J.	87	92
N. Y. & Pa.	.....	.....
New England	43¾	44
*Southern Bell	125	135
ELECTRIC LIGHT		
*Am. Electric	.....	.....
*Brush	.....	.....
*Brush Ill	.....	.....
*Consolidated	.....	.....
*Daft	.....	.....
*Edison	237	240
*Edison Ill	99¼	100
*Edison Isolated	.....	.....
*United States	40	50
*U. S. Ill	90	95
MOTOR.		
*Daft	.....	.....
*Sprague	.....	.....

* These stocks are so seldom dealt in that it is difficult to give prices at which they can be bought or sold. The figures given are as near as can be ascertained.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

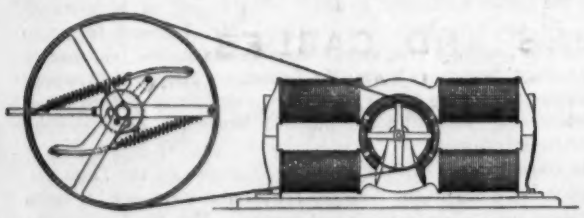
PATENTS DATED MAY 10, 1887.

362,510. Regulator for Dynamo Electric Machines; E. T. & D. Higham, of Philadelphia, Pa. Application filed June 29, 1886. Dynamometer springs are placed between the engine and dynamo shafts, and devices are employed whereby irregularities at the dynamo will be taken up by the springs, and the other devices will operate to control the supply of current. See illustration.

362,531. Voltaic Battery; A. F. W. Partz, of Philadelphia, Penn. Application filed Nov. 27, 1886. The cathode is formed of rods or bars of carbon arranged with narrow spaces between them around a porous clay cell containing an anode. See illustration.

362,584. Electric Battery; D. Misell, of New York, N. Y. Application filed Sept. 15, 1885. Improvements in the details of a battery best adapted for medical or domestic purposes.

(1) 362,639. Method of Working and Forming Secondary Batteries; (2) 362,640. Secondary or Storage Battery; W. I. Ludlow, of Cleveland, Ohio. Applica-



362,510. REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

tions filed (1) Nov. 13, 1886; (2) Nov. 29, 1886. (1) Claim 1: In the art of working primary and secondary batteries the method of effecting a penetration of the electrolyte into the body of the electrodes, consisting in placing the latter in a closed chamber, creating a vacuum in the latter, and then admitting the electrolyte. (2) The object is to provide a secondary battery of great storage capacity, which may be conveniently and easily transported without danger of disarrangement of its elements, and also a battery that is particularly adapted for certain purposes.

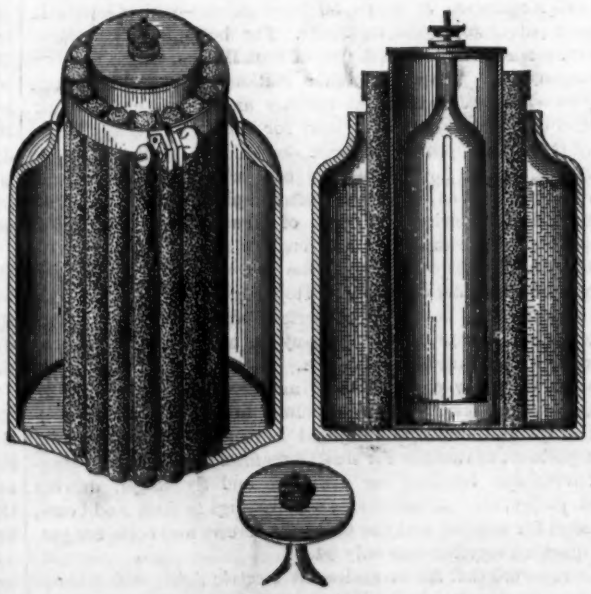
362,652. Testing Apparatus for Telephone Exchange Switches; J. J. O'Connell, of Chicago, Ill., Assignor of one-half to A. C. Holland, of same place. Application filed Jan. 14, 1887. The object of this invention is to dispense with the extra or test battery, which has heretofore been used in direct circuit with the telephone receiver to produce the "click" signal therein by the passage of a current from such battery on to the "busy line."

362,682. Loop Insulator; H. Van Sands, of New York, N. Y. Application filed Jan. 26, 1887. This insulator has opposite overlapping shields, one within the other, so arranged as to prevent the entrance of moisture.

362,739. Automatic Electric Danger Alarm; J. J. Ghegan, of Newark, N. J., Assignor of one half to A. Albright,

363,872. INSULATING THE TERMINALS OF SHEATHED CONDUCTORS.

of same place. Application filed Nov. 24, 1886. This is an apparatus for indicating whether a watchman, whose duty it is to make a record of his movements from time to time, has faith-



362,531. VOLTAIC BATTERY.

fully performed his duties, and is also designed as an alarm when the watchman is prevented from making his record.

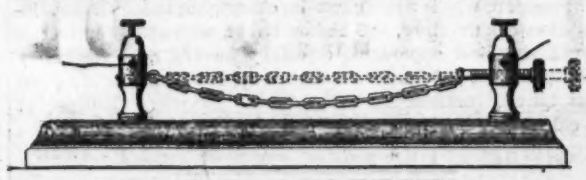
362,798. Electro-Dynamic Motor; C. J. Van Depoele, of Chicago, Ill. Application filed Oct. 29, 1886. A new method of winding the field, whereby an electric motor is produced capable of running with a constant speed under a variable load.

362,801. Lightning Rod; F. Westcott, of Buffalo, N. Y. Application filed Aug. 12, 1886. Improvements in water tank rods, wherein means are provided for readily filling and emptying the tank.

362,847. Electric Battery; O. Lugo, of New York, Assignor to C. M. Thompson, of Brooklyn, N. Y. Application filed Jan. 6, 1887. An electric battery in which one element is immersed in an acid and the other in an alkaline solution containing a substance which will retard or nearly prevent interdiffusion of the liquids.

362,852. Electric Lamp; C. M. Noble, of Anniston, Ala. Application filed Nov. 11, 1886. Improved feed mechanism, cut out and other details relating to that class of arc lamp in which the carbons form a V.

362,859. Variable Electric Resistance; J. M. Stearns, Jr., of Brooklyn, N. Y. Application filed Nov. 27, 1885. This resistance consists of a chain which, when limp, offers considerable resistance, but when taut offers but little resistance. The



362,859. VARIABLE ELECTRIC RESISTANCE.

amount of the resistance depends on the tension of the chain. See illustration.

362,872. Insulating the Terminals of Sheathed Electrical Conductors; D. Brooks, of Philadelphia, Pa., Assignor of one-half to H. B. Tatham, of same place. Application filed Feb. 21, 1887. A short portion of the sheathing near the terminal is detached or parted from the remainder, and the space filled with a sleeve of material which is both a non-conductor of electricity and a moisture resistant. See illustration.

362,902. Circuit Controller for Self-Winding Clocks; C. H. Pond, of Brooklyn, N. Y. Application filed Feb. 4, 1887. Improved means for completing an electric circuit in a clock for the purpose of winding the same by a rotary electric motor.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patent issued since 1866—can be had from this office for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, New York.

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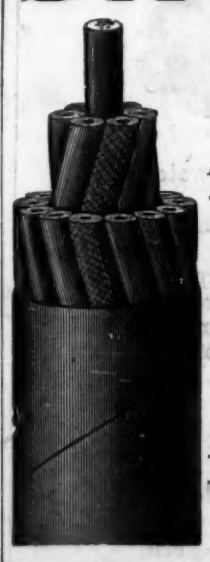

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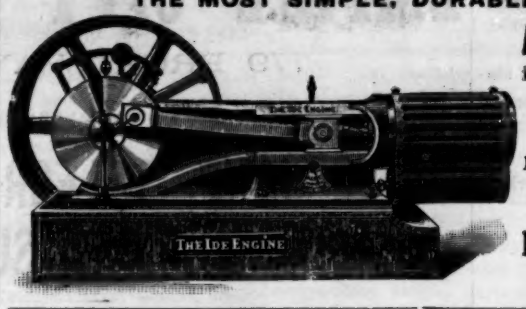

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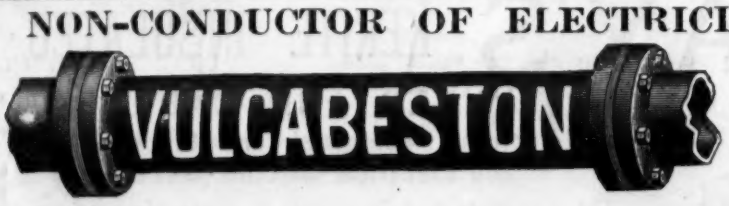

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